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NOTICE TO READERS

The answers received from members of the American Orthopedic Association and other readers of the Journal of Orthopaedic Surgery to the notice inserted in the August number of the Journal in reference to a change in form from a monthly to a quarterly publication have been so overwhelmingly in favor of the latter that the Executive and Editorial Committees of the Association have decided to make the change beginning with the January issue.

In issuing the Journal every three months it will be possible to present to the readers fully as much, or even more, reading matter than under the existing arrangement, and it is hoped that the Journal may be made more valuable and interesting.

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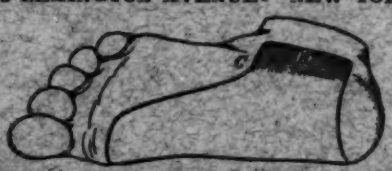

Shows the under surface of the brace and the outer flange. B—The calcaneocuboid articulation. C—The extremity of the fifth metatarsal bone.

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The Journal *of* Orthopædic Surgery

THE PRINCIPLES OF THE SURGERY OF THE PERIPHERAL NERVE INJURIES OF WARFARE.*

BY HARRY PLATT, M.D., M.S., F.R.C.S., MANCHESTER, ENGLAND.

FROM the experience derived from a personal study of more than 1500 patients suffering from gunshot injuries of peripheral nerves, and particularly of a series of over 500 operations, it is proposed to bring forward in brief form some of the considerations which have appeared to the writer as of outstanding importance in connection with this field of surgery. It must be admitted that in one's own work as in that of many other surgeons, postoperative end-results are not forthcoming except possibly in a very limited number of cases. But although such definite knowledge is lacking, much valuable information has been acquired. In a large series of operations one has had many opportunities of investigating the living pathology of injured nerve trunks. Further, the mechanical problem encountered in connection with the actual surgical repair of nerve lesions has caused us to resurvey the physiological and anatomical foundations of peripheral nerve surgery, and to realize the influence of certain factors in determining our surgical attitude towards any given type of lesion. Then again, a study of interim results, and in general a consideration of the regenerating nerve under many widely varying abnormal conditions, has contributed also to the formation of a reasonable surgical attitude.

* Paper read before the American Orthopedic Association at the annual meeting in Boston on June 4, 1921.

FACTORS INFLUENCING THE SURGICAL ATTITUDE.

Physiological Considerations.

Although the bulk of the evidence from all methods of observation may be said to be in favor of the adoption of the central theory of regeneration, it is unnecessary to be unduly dogmatic on this point. Whatever may be the exact limitations of the capacity of the peripheral part of the nerve trunk to share in the regenerative process as a whole, it is to be recognized as essential in surgical repair that there should be no obstacle to the access of the axis cylinders of the proximal trunk to the neurilemmal sheaths in the distal trunk. But the importance of the controlling influence of the spinal cells in the phases of regeneration must not be overlooked. The prolonged existence of a block in the peripheral nerve is always associated with marked retrogressive changes in these cells. In time, the cells lose their full capacity for the exhibition of a perfect control of the regeneration. It is not certain also that having once initiated the regenerative process, after the production of a second new lesion, these cells can repeat with success their regenerative domination. Thus, we see the importance of the early repair of a nerve lesion—early suture—and also the risk involved under certain circumstances, in the deliberate production of a second complete lesion at operation after regeneration has been established.

Anatomical Considerations.

Apart from the obvious essential general anatomical knowledge connected with the surgical exploration of nerve trunks, three considerations are deserving of special mention.

1. *Nerve Topography.* A crude but inconstant internal anatomy may be assumed to exist in the case of most of the larger nerve trunks, and particularly in the sciatic nerve, and in the median and ulnar nerves in the upper arm. In its surgical application, topography is of importance in relation to (a) the mechanics of end to end suture, where the avoidance of longitudinal rotation of the proximal and distal stumps is to be considered fundamental; (b) the feasibility of the recognition of partial lesions and their conservative resection. This it must be confessed is a theoretical rather than practical application, and (c) the condemnation of the operations of nerve anastomosis which

are either topographically inexact and useless, or if by any chance accurate, involve an unjustifiable degree of destruction of the recipient health nerve.

2. *The Muscular Branches of the Peripheral Nerves.* An exact knowledge of the position, distribution, and number of the muscular branches of the nerves commonly exposed at operation is essential to the surgeon. Confusion may arise in the investigation of the neurological syndrome if it be not remembered that direct lesions of muscular branches often coexist with lesions of the nerve trunk proper. The procedure of stripping such branches from within the sheath of the parent-trunk, or conversely of freeing them in their extramuscular course, is one of the most important manœuvres in facilitating end-to-end suture in the case of extensive gaps. Occasionally the sacrifice of one or more branches may be required to attain this end, and where a double supply exists to any particular muscle, such a sacrifice will happily produce no added disablement to the patient.

3. *The Blood Supply of the Peripheral Nerve Trunks.* The wide freeing of nerve trunks, which is a commonplace in the repair of many of the warfare lesions, involves of necessity the obliteration of a considerable part of the vascular supply derived from extraneural sources, and this especially in the distal part of the limb. Such extensive dissections have been shown to produce no ill results as regards the occurrence of gross changes in the component tissues of the nerve trunks so dealt with nor any inhibitory effect on regeneration. These conclusions have been confirmed by the experimental work of Torraca.

Pathological Considerations.

There has been a tendency to apply many of the established principles of civil nerve surgery en bloc to the treatment of the warfare lesions. In the nerve lesions of civil life, "secondary" injuries—compression lesions—constitute a large and important class. But the warfare injury is notably primary in its inception, the actual nerve block is intraneural in position, and the conduction of the trunk is little influenced by extraneural conditions. For this reason the operation of simple neurolysis is here likely to play a subordinate part.

The dominant rôle of wound infection, whether attenuated or moderately severe in type, which is characteristic of the injuries of modern warfare, provides in addition to the gross primary lesion of the nerve, the insidious extension of interstitial neuritis for considerable distances proximal to the limit of the initial lesion.

THE OPERATIVE EXPLORATION OF NERVE INJURIES.

General Considerations.

Of the many important points which cannot be dealt with fully in a short paper one would lay emphasis on the following: (a) the routine use from the commencement of the operation of the widest anatomical exposure; (b) the constant employment of direct electrical stimulation by means of the bipolar electrode; (c) the standardization of such positions of the patient and limb on the operating table in which the difficulties of obtaining end-to-end suture are minimized.

Result of a Series of Operations.

In my own series of 510 operations performed up to December, 1920, information concerning the late results has been accumulated in 248 patients. These operations include, end-to-end sutures, 150; neurolysis, 80; bridging operations (grafts and tubulizations) 18. In connection with the latter group of operations the complete failure of all my personal operations of this type was reported a year ago, so that no further reference will be made to them here.

A. Suture Results. Of the 150 operations, recoveries of varying types and degree were seen in 79% and complete failures in 21% of the cases. Amongst the factors which have determined or inhibited recovery and which are worthy of discussion are the following:

1. *The Period Since the Injury.* With increasing periods of delay are seen progressively inferior results. This is due, in my own view, not necessarily to the development of degenerative changes in the muscles, but to the retrogressive changes in the spinal cells already referred to.

2. *Infection.* Immediate postoperative recrudescence of infection occurred in one operation only in my series of 510, so that one has had no personal opportunity of confirming the generally assumed disastrous effect of such a mishap on the process of regeneration. Infection has been seen, however, at a period remote from the time of the operation, manifested as a spontaneous recrudescence in some previously encysted focus, particularly in connection with a coexistent bony injury. Further, in a number of sciatic nerve injuries, the development of bone necrosis in the head of the fifth metatarsal or distal

phalanx of the great toe, occasionally associated with trophic lesions in these regions, provides a distal source of sepsis which I believe is absorbed by the regenerating nerve. Its effects are shown in the delay in regeneration in such cases and also in the production of symptoms of irritation in the internal popliteal distribution during the recovery stage. This sequence of events has occurred in a number of sciatic injuries in my own experience.

3. *The Nerve Bed.* From my observations the effect of the surroundings of the sutured nerve has been almost negligible as regards the regenerative process, except where the nerve trunk has been subjected to the friction of bony surfaces, or left in direct contact with injured tendons.

4. *Topography.* Topographical errors inevitably account for many of the total failures or imperfect recoveries, and may be taken as explaining in part the superiority of the recoveries seen in an almost purely motor nerve, such as the musculo-spiral. Again, the failure of suture of a small nerve to a larger trunk, or of two small nerves to a common large trunk, which is a conspicuous feature in a number of my operations, is to be explained by an inexact topographical apposition.

5. *The Level of the Suture.* Our observations go to show that regeneration in the distal part of the limb is apt to be fickle, irrespective of the level of the lesion or suture. This has been pointed out some little time ago by my colleague, Stopford, and has also been emphasized by Stracker of Vienna.

B. Neurolysis Results. In 75% of the cases followed up, improvement and recoveries were seen, but it has been difficult to prove the exact influence of this operative procedure *per se* on the restoration of conductivity.

THE QUESTION OF LATE EXPLORATION AND REËXPLORATION AFTER FAILURE OF PREVIOUS SUTURE.

At the present time the optimum period for exploration of the nerve injuries sustained in 1918 is past. For the few unexplored lesions of a date previous to this, an even worse prognosis is to be given. The same criticism applies to the reëxploration of failures, so that the alternative operations for the restoration of function now loom large in our repertoire of reconstructive procedures. These latter are now practically standardized and their consideration does not enter into the scope of this paper.

	Total	Proximal Muscles only	Proximal and Distal (incomplete)	Proximal and Distal (total)	Distal Alone	Associated Sensory Recovery	Sensory Recovery Alone	Number of Recoveries	Failures
Musculo-spiral	35	10	11	5	—	all	—	26	9
Median-upper arm	10	7	3	—	—	in 5	—	10	nil
forearm	20	3	—	—	6	in 6	8	17	3
Ulnar-upper arm	27	19	3	—	1	in 14	1	24	3
forearm	20	—	—	—	10	in 14	7	17	3
Sciatic-trunk	21	16	nil	nil	—	in all	—	16	5
segmental	4	2	nil	nil	—	in all	—	2	2
External poplital	9	4	nil	—	—	in all	—	4	5
Posterior interosseus	1	—	—	—	—	—	—	nil	1
Plexus	3	2	—	—	—	2	—	2	1

Recoveries 118=79%
Failures 32=21.3%

	Suture	Neurolysis	Bridge	Repair Abandoned	Partial Suture	Exploration No Lesion	Exploration Nerve Left in Situ	Injection	Exploration First Stage	Total
Brachial plexus	5	4	—	—	—	2	—	—	—	11
Musculo spiral	51	15	5	14	—	1	—	—	—	87
Median	70	45	6	—	5	2	3	1	—	132
Ulnar	115	49	12	—	—	1	5	—	—	182
Posterior interosseus ...	1	—	1	—	—	—	—	—	—	2
Sciatic	51	9	3	—	2	1	—	—	4	70
External popliteal	14	2	—	6	—	—	—	—	—	22
Internal popliteal	—	2	—	—	—	—	—	—	—	2
Posterior tibial	—	1	1	—	—	—	—	—	—	2
	307	127	28	20	7	7	8	1	5	510

Operations for severe causalgia: Median, 14; sciatic, 10; internal popliteal, 1=25
Operations in which end-to-end suture failed. 53
Successful suture at second attempt 1
Failure of suture at second attempt 3

DISCUSSION OF MR. PLATT'S PAPER.

Dr. Edward Gallie, Toronto, Canada: *Mr. President and Gentlemen:*—It is impossible for me to assist Mr. Platt very much in discussing this paper, as our experience in the Canadian Army has been so similar to his that a detailed discussion would simply be a repetition. I might draw your attention to several points in the paper which it would be well to remember.

In the first place, the experience of the war has shown that the suture of injured nerves is an operation from which very satisfactory results may be anticipated. Despite the serious nature of the original injuries and of the subsequent infections, an extraordinarily high percentage of good results has been recorded. In civilian practice, therefore, we should profit from our war experience and give every patient suffering from such injuries the opportunity of obtaining restoration of lost function by suture of the nerves.

In the second place, the old dispute as to how regeneration of the nerves takes place appears to have been definitely settled. The investigations of the Medical Research Committee have shown that recovery takes place as the result of the slow downward growth of the axis cylinders from the point of the lesion. No authentic cases have been observed in which recovery took place more rapidly than could be accounted for by this downward growth of the axone.

With these preliminaries definitely decided, the most important question to the student is how to account for the variation in results obtained from operation. It has been generally accepted that in order to establish any certainty whatever of a successful result, actual end-to-end suture of the nerve must be obtained. While partial recoveries occasionally occur after nerve grafts, fascial tubulization, etc., these are so rare and the functional improvement so slight that such operations are really not worth while. Every effort should therefore be made, by dissection, mobilization of the segments of the nerves or by flexion of the joints in the region of the injury, to bring the ends of the nerve together. If this is finally shown to be impossible, the suggestion of drawing the bulbs as closely together as they will come, with silk, and leaving them so for a couple of weeks will often make end-to-end suture still feasible. I have seen a gap of two inches ultimately closed by this method.

My experience has led me to believe that the character of the results depends very much upon the way in which the suture is performed. I feel sure that the rather high percentage of failures which followed my earlier operations was due to unskillful technique. This percentage of failures steadily diminished as we improved our technique, particularly in the matter of the gentle handling of the nerve, the accurate approximation of the cut ends, the taking of care that one segment was not rotated on the other, and the use of fine needles and delicate sutures which entered only the sheath of the nerve. Many operators have found that after long and difficult dissection necessary to get the nerve ready for suture they are too exhausted to do the delicate work necessary to obtain an accurate closure of the wound. In such cases it will be found useful to have another operator take charge of the final stage of the operation.

We have been so impressed with the importance of accuracy in suturing the nerve that recently we have used a large magnifying glass placed between the operator and field of operation. This so enlarges the structure that accurate suture is easily obtained.

Mr. Platt has drawn attention to the importance of carefully splinting the limb in such a position that dangerous tension on the nerve will be avoided. This is comparatively easily secured in the case of the arm and leg but is more difficult in wounds of the sciatic nerve. A plaster spica applied with the hip extended and the knee flexed makes it difficult for the patient to lie comfortably in bed. To get over this difficulty we adopted the plan of placing these patients in beds which were so constructed that a space could be made between the sections of the mattress and part of the springs removed, so that with the patient lying on his back his leg passed through the bed and his foot rested on the floor. He could thus wear a plaster spica in comfort.

DR. MURRAY S. DANFORTH, Providence, R. I.: I feel that we are to be congratulated on the fact that Mr. Platt has been able to follow so many of the cases that he had previously done. I recently attended a meeting of the United States Army Peripheral Nerve Commission in which the various men told their experiences in trying to follow up their cases, and of the difficulty of getting accurate reports, with the patients scattered in various parts of the country.

It was very discouraging, although in some instances the men had been able to correlate their previous examination and operation with the present condition of the patient. It is only by getting the carefully prepared reports of Mr. Platt, the reports of the work at Edinburgh recently presented by Dr. Forrester-Brown, and the work of the men in Canada, together with the reports of the comparatively few cases done in the United States that the hoped for contribution to neural surgery could be made.

I feel that I can add very little to what Mr. Platt and Dr. Gallie have said, but there are one or two questions that I hope Mr. Platt will answer. One of them is the question of the relief of pain in some of the cases of nerve injury where suture has been done, and where exploration has been done and some change in the nerve found, but not a change in the nerve that required resection. What can be done in these cases to relieve the pain? This is of importance to the surgeons in charge of soldiers still under treatment in the United States.

There is one other question to which possibly the answer was suggested in a paper given by Dr. Harris before the Orthopædic Club. In a case of loss of sensation in the median area, where it had been impossible to suture the nerve, Dr. Harris took the ends of the radial and anastomosed them with the peripheral part of the median nerve. He reported one case in which this procedure was followed by considerable restoration of sensation in the median area. I should like to ask whether Mr. Platt has had any experience in this.

The point brought out by Mr. Platt of the possible lack of value in electrical stimulation at a secondary operation, where suture had been made without restoration of power, is of interest. I understood him to say that electrical stimulation might produce contraction of the muscles, but that it was produced through the sensory fibers. It is a point of very great value to know; otherwise, we shall be deceived.

The point brought out by Dr. Gallie that in cases where it has been impossible to bring the nerve stumps end-to-end, one can anchor the stumps in as close approximation as possible and at a second operation, do an end-to-end suture—is of value, as end-to-end suture only is of value in restoring function.

MR. HARRY PLATT, Manchester: Dr. Gallie has had a wide experience in operating on these cases and I do not think my views differ very much from his. The arrangement whereby two surgeons are employed, working in shifts in a long and tedious operation of nerve suture, is an admirable one.

The operation of Harris of Toronto I have not done yet but I am expecting to try it on a patient in a very short time.

With regard to the question raised by Dr. Danforth on methods of relieving pain, I must say that in a number of my sciatic nerve sutures in which severe pain has followed during the time of regeneration nothing has been found to give relief, and I am afraid that I know of no form of treatment which can effect this with certainty.

PREVENTIVE AND PROPHYLACTIC ORTHOPÆDIC PRACTICE.

BY C. L. LOWMAN, M.D., LOS ANGELES, CALIF.

As orthopædic surgeons we are, and have been, actively engaged since 1914 very largely with operative and reconstruction work. Many hundreds of the younger men of the profession have taken in-

tensive orthopædic training and have been dealing almost entirely with the results of war injuries and their sequelae, as well as those questions of faulty statics which are evidenced in soldiers.

The surgery of war injuries has emphasized the necessity for prophylaxis in regard to future function of parts, and the positions for usefulness of various members have been pointed out over and over again.

The orthopædic clinics in our army hospitals have large numbers of cases in which faulty statics played the greatest rôle in the causation of disability.

I have been interestedly noting the fact that probably 80 per cent. of the soldiers who present themselves complaining of back symptoms, especially referred to the low back, are of the long backed type with varying degrees of malalignment, and in more than half of them various anatomical deviations in the sacro-lumbar region are seen in the x-rays. We do not yet know the exact relation of these deviations to the symptom complex, but the frequency with which we get these findings seems to me to be more than a mere coincidence.

The enormous number of postural cases, both rejected from the service and still in the service has been pointed out and talked of until it is common knowledge, and the rejected and discharged for foot defects alone, when the final figures are compiled, will certainly be great. When we stop to think what the causes of these disabilities are, and remember that findings of many investigators show that 70 to 85 per cent. of all our school children have postural defects, the relation seems perfectly obvious.

Under the strain of military life, the potentially weak break down, and the same holds true in civil life, except that the stress and strain is applied more gradually and the disabilities are not apparent at so early an age.

Although orthopædic surgery is a specialized branch of surgery, it has a very broad outlook and many angles of activity.

The surgical corrective aspect deals with pathological and reconstructive problems. Preventive surgery deals not so much with the operative as with the nonoperative type.

Perhaps the more spectacular surgical side is alluring to some, but certainly the influence of preventive surgery on the health and efficiency of the coming generation will give as great returns in helping to increase human happiness and usefulness.

The field for preventive effort is large and many angles might be

discussed, but I desire to bring to your attention only one phase, namely, physical supervision in childhood.

As I have just stated, it has been shown many times by examiners of groups of unselected school children that from 70 per cent. to 80 per cent. are physically defective from a postural standpoint.

If this is so, and the need for corrective procedures is so self-evident, the question arises—who is to be responsible for the institution and carrying out of these corrective procedures?

It is safe to say that in general, at least about 50 per cent. of the orthopædic surgeon's office practice consists of adults, and in varying degrees, according to the interest and importance attached to faulty statics, the conditions for which these adults are treated are functional faults.

Joint conditions, due to improper weight-bearing, with or without other definite pathology, arthritis, periarthritis, periostitis, neuritis from such conditions as flat feet, pronated ankles, knock-knee, torsion deformities, short leg, faulty spinal alignment, in one or both planes, disturbances of alignment and weight-bearing in the pelvic and shoulder girdles make up a large part of our daily work.

How many cases of subscapular bursitis and other shoulder girdle neurites, from use in malposition, must we see in the adult before we realize that had proper attention been given in the growing years, this end-result would have been avoided?

How long are we going to teach that moderate degrees of bowlegs in children will be outgrown, when our offices and clinics are full of adults with valgus ankles and flattened feet because of moderate, uncorrected bowleg?

The apparent correction of the deformity by close apposition of the legs is simply due to the fact that a compensatory angle has occurred below the ankle, caused by the weight being thrust inward by the curved tibial lever.

In latter years the result of flat feet and other disturbances of leg alignment ensues. No amount of ordinary treatment can give these adults anything but symptomatic relief.

The same is true to a lesser extent of knock-knees, but more attention is directed to this in childhood and more corrections obtained.

Torsion deviations: Rarely have we seen much attention given to this condition, which is quite common and causes ultimately nearly as much joint and muscle strain and tissue changes as deviations in other planes.

How long are we to treat scoliosis caused by short legs before we

attempt to institute some general action looking to the discovery early in life of the factors which underly the curvature?

We certainly have all seen and appreciated the wonderful improvement in health which is manifested in a body of soldiers after the routine drill and setting up work has straightened their spines and corrected to a large extent the general tendency to visceroptosis.

We know their physical efficiency as well as their health is improved. Why should we not give to all the coming generation the value of the lessons in physical efficiency which our experience in the army has given us?

Reconstruction work is a very necessary thing in war and the industries, but there should not be much need for it during childhood.

Constructive work is wanted here, the prevention of those conditions which most certainly are important factors in lowering the health and efficiency standard in the adult. Our own children probably fall in this class, which is 80 per cent. of the total number of school children.

How is a program of constructive physical supervision and education to be brought about, and who is going to do it? We have a growing group of men and women engaged in physical educational work, only a small percentage of whom know much of corrective methods. As a class they are enthusiastic, willing, and interested in this problem, but they lack guidance.

Only in our large centers do they come in contact with orthopædic procedures, and even there only the high schools and colleges have gymnasia, so that there is practically very little attention given to the postural defects in the grammar grades.

This is expressly the age when the most careful work should be done. Shall we continue to leave the responsibility of training physical directors entirely in the hands of *educators?*

If the methods in use do not meet the needs in this matter of corrections, changes must be made. Should we not be the ones to suggest the changes?

We should be the ones to outline for the physical directors the necessary procedures, looking to the correction and prevention of postural defects. More of us should have a hand in the training of those entrusted with so important a branch of our work. Most of us are training directors for our office and clinical work, but very few have in any way modified practically the methods in vogue in the physical supervision and training of those handling the mass of our school children.

The most effective and far-reaching work must be done during the grammar school age. As gymnasia in grammar schools are seldom seen, all the exercise the children have, which could have any corrective value whatever, is given by the grade teachers under a general supervisor who is responsible for all the grammar school work in the city.

It is not too much to demand that a trained physical director, schooled in preventive methods, and competent to recognize potential defects and deviations, should be assigned to each school. It should be her duty to act in an advisory capacity to both teachers and parents, to look over and observe all children who need special attention to their physical needs. She could refer these cases to the proper examiners and carry out their recommendations as to any general procedures decided upon.

Supervision of games is a particularly important phase of this work, and it is possible by intelligent choice to arrange certain activities to meet certain needs and to check vicious activities, such as some form of folk dancing, jumping rope, skating, etc., in children with flexible flat feet.

All physical activities can be altered to meet the gross needs of the group and will thus result in greater value to the individual.

We have found that a rough classification can be made by an examiner properly trained, sufficiently accurate to divide most of those with obvious defects like pronated ankles, flat feet, knock-knees, round shoulders, round or hollow backs, unlevel hips and shoulders, from those more nearly normal.

Briefly, the method we have employed is this: At the beginning of the quarter or semester, the new pupils are lined up and the examiner, accompanied by a secretary, passes down the line and notes, first, all cases of unlevel shoulders,—again, passing a hand down the curve of the waist and hips and then placing the thumbs on the anterior superior spine of the ilia, unlevel hips or tilted pelvis are noted.

The secretary notes the pupil's name, each time under each defect. Lining them up again, the examiner approaches from the end of the line, passing the hand over the back, notes prominence of scapulae, round, flat or hollow back, and head position.

Position of the squad is again assumed and by slight pressure backward on the knee as well as by direct inspection, back knees are detected. Next, have the pupils stand with feet parallel, knees touching. Those whose malleoli touch and condyles do not, obviously have varying degrees of bowlegs and the converse detects knock-knees.

In the feet parallel position, if the patella points toward the median line of the body and not forward in the median line of the leg, there exists inward rotation of the leg and compensatorily pronated ankles or relaxed arches.

Bring the class to attention again without calling attention to their feet and note foot positions. In gymnasium slippers it is easy to observe faults in foot alignment and notation is made as to pronation and relaxed feet.

When this data is assembled it will be found that certain ones will be registered for two or three defects, or, in a word, are generally relaxed. This worst group should have immediate attention. Word should be sent to the parents for permission to make a detailed examination with clothing removed, and in cases that need expert attention they can be referred to the proper clinics or orthopædic surgeon for necessary care.

In this way there will not be a loss of a month or more before the examiners are aware of some of the worst cases, and, furthermore, they would not be able otherwise to estimate the size of the groups needing special attention to certain things.

On this basis they can adjust their corrective and general gymnastic procedures.

Fifty or sixty pupils can be thus roughly gone over in an hour and with a little experience and knowledge of types the gross errors can be detected.

In any group of school children fully 65 per cent. will have two or more of the above mentioned deviations; consequently, the earlier they can be recognized, and the earlier any or all of the proper prophylactic procedures can be instituted, the better for the children thus afflicted.

The worst cases could be taken out in squads and have special exercises given, but as it will take some time to get to this stage, a good start can be made by modifying as much as consistently possible all the games and activities which will influence these conditions.

Supervision should also be extended to physical surroundings, seats, desks, chairs, etc., and their adjustments examined to see that they are correct for the various children under consideration.

In acting in an advisory capacity to the parents, much good would ensue. Inquiry should be made in regard to the child's habits and activities while out of school, home surroundings, bed postures, feeding, hours of play and sleep.

Clothing and its effect on posture should receive its share of con-

sideration, and most mothers are very glad to be informed as to correct corsets and corset waists, brassières, etc.

Whenever it is possible to have gymnasium facilities, the supervisor of corrective activities should change type, order, and progression of exercises to obtain the greatest individual benefits to the whole group taking work under her.

One example of this would be shown, for instance, by a method which we had used in our gymnasium for years and which has been subsequently used in several schools in our vicinity, namely to plan out a whole progression of exercises given in recumbent, procumbent or sitting positions. We have long advocated that enough stools and mats be included in the gymnasium equipment to make this possible.

You probably know the value of toning up exercises in these positions and use them in your own practice as I do, but they can be used as well in group work as with individual cases.

Some of the advantages of the method are, briefly: The lying position rules out the effect of lateral asymmetries, such as short leg, unilateral flat-foot, or knock-knee with its pelvic tilt, and scoliosis.

The straightening out of all spinal curves in the early stages.

The fixation of the scapulae and corrective effect on antero-posterior curves.

The margin of safety allowed in reference to heart and respiratory strain.

The improved position of the viscera.

The sitting posture is an especially good one in flattening the lumbar curve while the shoulder, scapular, and chest exercises are given.

Fatigue is not developed so rapidly because of the lessened balance strain.

In short, it allows corrective work to be given in corrective positions, a statement which should be axiomatic.

Instead of having the high majority with postural defects stand and exercise in positions of faulty alignment, is it not better to have the small majority who are normal assume the positions and do the work which will gain the maximum good results for the needy majority?

I recognize the fact that in two or three of the larger centers where there are many orthopædic surgeons, some of them have long been giving time and thought to the development of physical trainers and gymnasts, but through the country at large how many state normal schools, colleges, and universities giving major courses in physical

training, have orthopædic surgeons on their faculties or even remotely connected with them?

It is perfectly obvious that there are not enough men interested in orthopædic work to see even a fraction of this 80 per cent. of children who need the attention of trained individuals. Consequently, if this field is to be cultivated and a harvest gained, it will have to be done largely by men and women trained to do it.

All of us who are or have been connected with the reconstruction work appreciate that a great part of the credit for the results obtained belongs to our Reconstruction Aides, the greater number of whom are physical directors.

We are keenly conscious of the difference in value to this work of those who are experienced directors and those who had simply some special and intensive training.

This fact alone should make us realize that the well trained physical directors, who are graduated from schools giving courses in corrective orthopædic therapy, are to be the ones to transform our desires into facts, in dealing with this phase of the preventive and prophylactic problems of childhood.

The founder of orthopædic surgery included the postural and potential deviations in childhood within the purview of this branch, and it seems as though the responsibility for training these persons rests with us.

If, then, we will assume our share in the education and training of physical directors, we should use our influence to broaden the scope and raise the dignity of physical training as a scientific branch of education.

PRIMARY OSTEOMYELITIS OF THE PATELLA. CASE REPORT.

BY E. B. MUMFORD, M.D., INDIANAPOLIS, IND.

Assistant in Surgery, Indiana University School of Medicine. Visiting Orthopædic Surgeon and Chief of Fracture Service, City Hospital, Indianapolis, Ind.

R. B., white, aged 13, living on a farm, fell September 6, 1919, while playing ball and injured his right knee. There was not much pain at

FIG. 1.—Osteomyelitis of Patella.

FIG. 3.—Osteomyelitis of Patella.

FIG. 2.—Osteomyelitis of Patella. Sequestrum.

that time and he continued with his play. The second day following the accident he began to have pain in his knee and at the end of two hours had to be taken home as he could not walk. At this time the attending physician noted that the knee was swollen and there was some redness over the anterior aspect. Tenderness over and below the patella was also noted and all motions were painful. This condition remained unchanged for two weeks with the exception that the swelling increased and the pain became so severe that it was necessary to use morphine. During this period the temperature was elevated.

September 20, 1919, the patient was referred to me by Dr. Link. Examination showed a well developed boy. General condition fair. The right knee is swollen, tense, and shiny, but not very much redness. The patient is unable to move the knee and any attempt at passive motion is associated with great pain. Tenderness is most marked on inner side of knee and below the patella. Fluctuation is present over patellar tendon. The swelling extends up the lower half of the femur and tenderness is also present in this area. The x-ray plate was negative for any pathology of the femur or patella. Aspiration of the knee-joint gave only a small quantity of bloody fluid, free of pus.

September 21—Incision made on outer side of patellar ligament and about six ounces of thick pus evacuated. A smaller counter drainage incision made on inner side of ligament. The wound was washed out with salt solution and packed with sterile gauze. A diagnosis of an abscess of fat pad beneath patellar ligament was made. At this time nothing was observed as to any involvement of the patella. The following day Dakin solution was used and this was continued until October 1. The wound did not heal and examination with a probe showed denuded bone.

October 3—X-ray examination revealed an osteomyelitis of the patella (Fig. 1), the entire bone being involved.

October 4—A small, hard, painful, tender tumor appeared in the soft tissues of the lower third of the thigh. The temperature, which had been normal since operation, became 104 and associated with a hard chill. Hot applications were applied over this area and the temperature became normal on October 6. This tumor persisted for several days but finally disappeared without further treatment. It was probably a metastatic abscess.

October 11—A large sequestrum from the patella (Fig 2) was removed through the lateral incision. It was about one inch in diameter and honeycombed by the osteomyelitic process.

October 27—Wound clean and general condition of patient good.

November 17—Wound entirely healed. The treatment up to this time had been with Dakin solution. The patient had been having active mobilization during the entire time, but the motion of the knee was limited to about twenty degrees. Patient discharged home with lateral irons and advised to walk with full weight and to remove brace several times for active exercise.

January 1, 1920—Has about forty degrees flexion at knee and extension is normal. No pain.

April 7—Flexion of knee to 90 and extension to 180. No pain. No shortening of leg. Brace has not been worn for three weeks. Child is helping about the farm and has not any disability except loss of flexion.

X-ray at this date shows the patella to be a thin plate of bone (Fig. 3).

The interesting features of this case are:

1. Primary hematogenous osteomyelitis of patella, which is rare, following a slight injury.

2. The joint cavity of the knee was not at any time involved. This confirms the well-known clinical observation that a pyogenic osteomyelitis rarely involves the neighboring joints.

3. Good function end-result, although a greater part of the patella was destroyed by the infectious process.

ON COALITIO CALCANEO-NAVICULARIS.*

BY PROF. DR. SLOMANN, COPENHAGEN.

THE first suggestion I received for the study which I shall here have the honor of submitting to you, was on examining a patient who was admitted into my private clinic in February, 1916, suffering with a considerable deformity of the foot.

* Lecture given at the meeting of the Scandinavian Orthopedic Association at Copenhagen in May, 1920.

The patient was a young man of sixteen whose father stated that nothing abnormal had been noticed about the feet until the boy was four years of age. Since that time the deformity in his right foot has steadily increased; and though he did not suffer severe pain in the foot he walked badly and was very quickly tired. An examination disclosed flat-foot in both feet; but while in the left it was a case of ordinary planovalgus deformity with slight contracture of the triceps and a moderate restriction of movement, the right foot, which you see in the illustration Figure 1, was of monstrous shape, short and enormously broad, with convex rocker-shaped plantar and convex medial edge (Fig. 2). The heel and tarsus rest on the ground; but from here, the first metatarsal bone tips upward at the medial side of the foot, and only the point of the downward bent great toe again reaches the ground. The second toe lies over the first, which is deviated in valgus, so that the former is not visible from the planta. The muscles on the crus and the small muscles of the foot all seem to be in fairly good condition. Both the triceps and the dorsal-flexors are contracted; the movement in the talo-crural joint is small, only 20° to 30° in all, and the rotatory movements, the pro- and supination are as good as annihilated. The right leg is about 1½ cm. shorter than the left, measured from the spina to the internal malleolus. The Röntgen examination of this foot now reveals the most peculiar circumstance, that the os naviculare at its most lateral portion unites completely with the proc. ant. calcanei, is coalesced with the calcaneus in osseous coalition.

This condition is very distinctly observable in the dorso-plantar x-ray (Fig. 3), where the front limit for this os calcaneo-naviculare forms a beautiful S-shaped curved line, which is divided into facets for the cuneiform and cuboid, while behind, the navicular section shows a greatly diminished articular surface for the reception of the strikingly small caput tali. Among other peculiarities of the skeleton of this foot may be mentioned the diminutiveness (shortness from front to back) of the os cuboideum which does not seem much longer than the first cuneiform; the complete depression of the caput tali, which together with os naviculare lies quite at the medial side of the proc. ant. calcanei instead of above the same, whereby the great width of the foot is produced, (and finally as a certainly accidental combination the presence of an independent epiphyseal nucleus in the tuberositas Vti). In the illustration (Fig. 4) showing a side view of the foot, the coalition is seen in a typical way, which will be repeatedly found in all cases of this sort, namely as a huge mass of bone, or bone-bridge, which from the front portion of the calcaneus stretches up-

FIG. 1.

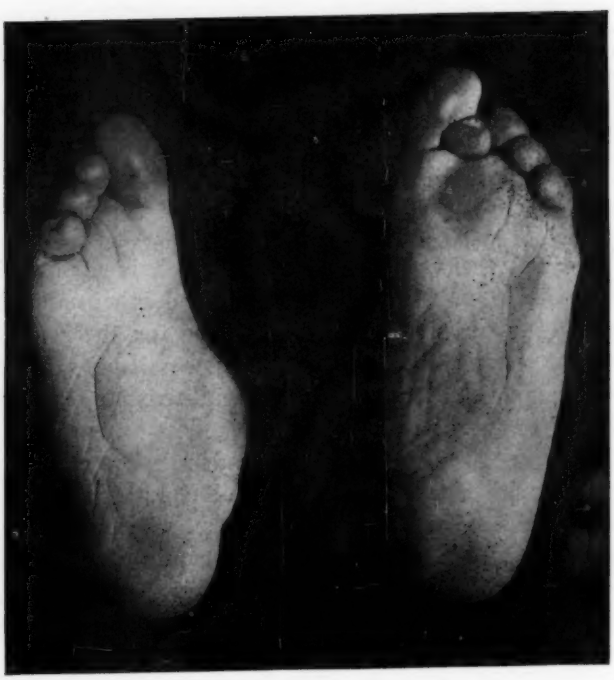

FIG. 2.

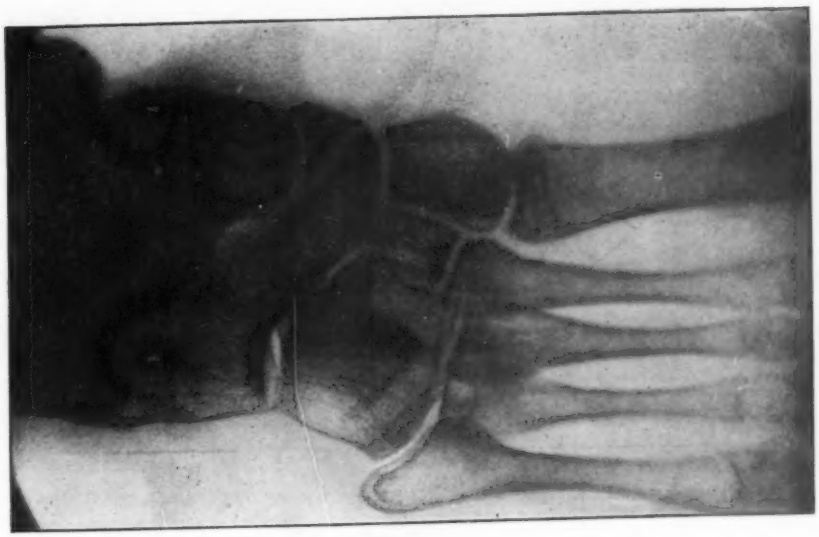

FIG. 3.

FIG. 4.

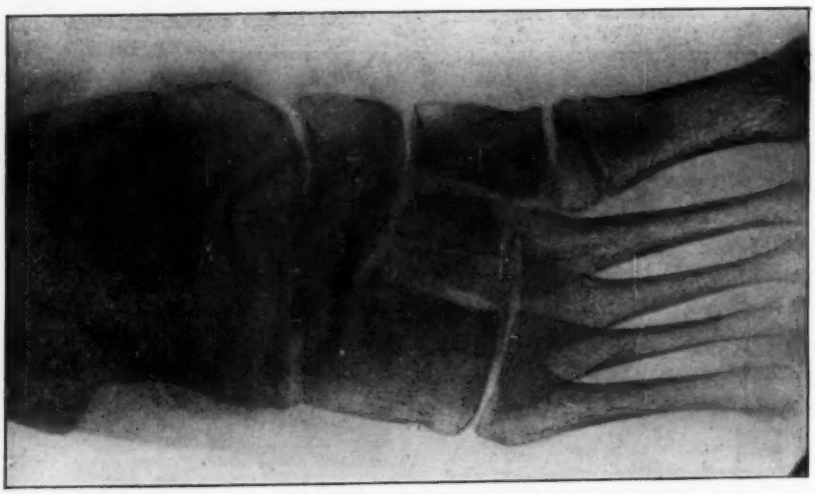

Fig. 5.

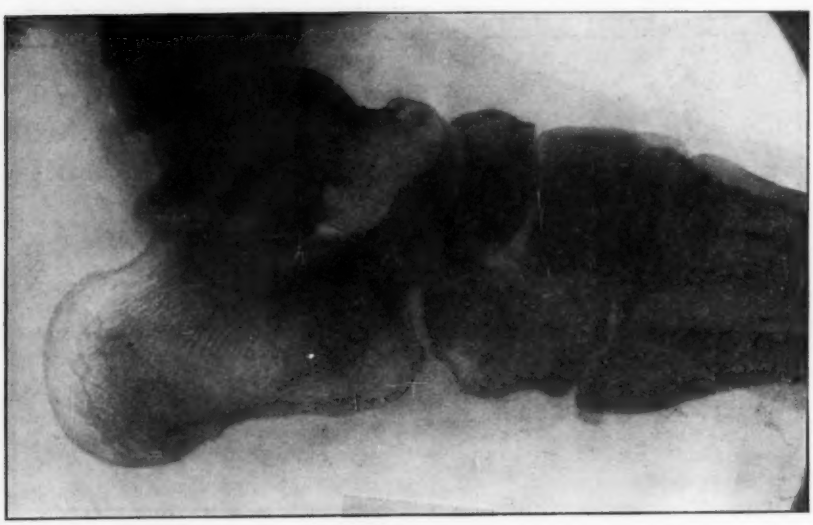

Fig. 6.

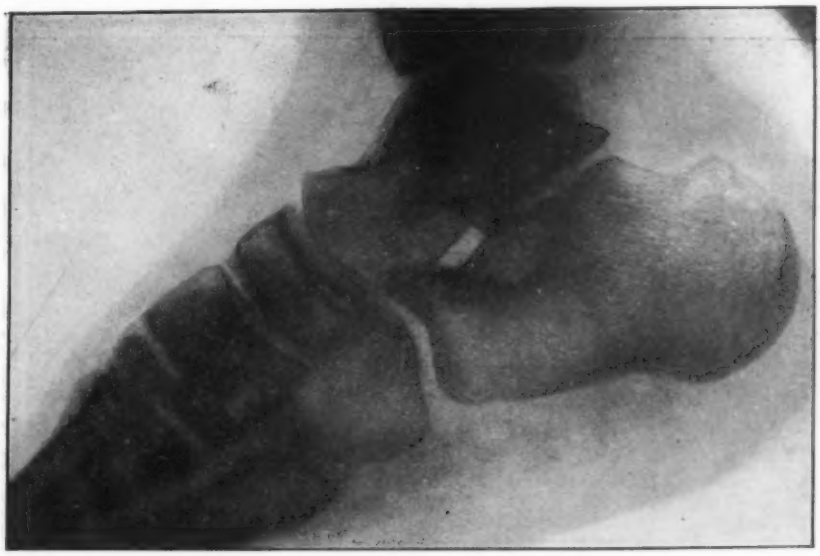

FIG. 7.

FIG. 8.

FIG. 9.

ward and forward and becomes one with the naviculare; transversely through this portion can be discerned the division of the joint between the latter and the here almost completely downward directed caput tali, the articular surface of which seems, for a great part, to rest on the bone bridge. Unfortunately in this case no side view of the left foot is obtained. Viewed from above, the skeleton of this foot does

FIG. 10.

FIG. 11.

FIG. 12.

not appear to reveal anything particularly abnormal beyond the usual attributes of the flat-foot.

It is consequently clear that, though the deformity was not observed until the boy was four years old, there evidently was a congenital abnormal formation in the skeleton of the foot; and it so happened, that I was already acquainted with this kind of abnormality. In Langenbech's *Arch. f. Klin. Chir.*, Vol. 25, 1880, I had, several years previously, come across two statements by Dr. Holl, at that time Demonstrator of Anatomy at Vienna, in which he described two cases of coalition or fusion between the calcaneus and the naviculare, in just the same manner as that here described. The first case involved only an anatomical preparation of the talus, calcaneus and naviculare from one foot of an adult; but even from that preparation Dr. Holl draws the conclusion that the foot has been a very pronounced case of flat-foot, and that this deformity or, more correctly, the cause of this was congenital; in the second case he found, on dissecting an infant a few days old, with flat-foot in both feet,—exactly in the same manner as I have described above, the calcaneus and naviculare directly uniting while forming a continuous mass of cartilage. Finally he mentions a similar instance described by Zuckerkandl, likewise from the Anatomical Institute at Vienna. Here, however, the connection between the two bones was not bone,

but was composed of an exceedingly firm, hard, fibrous tissue, over the front of which the cartilaginous covering from the front surface of the os naviculare fused directly with the front surface of the calcaneus, where that bone articulates with the cuboid. The fibrous tissue in question contained, posteriorly, a small wedge-shaped bony substance (3 x 5 mm.),—undoubtedly, I should say, an "os calcaneum secundarium."

The congenital abnormalities in the formation of the tarsus, of which the coalition here treated is a particular form, must as a rule be traced back to the extra bones in the foot-skeleton, the so-called tarsalia, *i.e.*, rudimentary bone corpuscles preformed in cartilage, which are invariable in their localisation, but very variable in regard to development, shape, and independence in relation to the typical neighboring bones, and which have been made the subject of thorough research by Wenzel, Gruber and subsequently by Pfitzner. Pfitzner's monumental treatise, constructed on a work of colossal anatomical detail: "Die Variationen im Aufbau des Fuss-Skeletts," in *Morphologische Arbeiten*, Vol. VI, 1896, is undoubtedly the most important work of reference on this subject; and also with regard to the point in question here, the information he gives is both copious and thorough. I shall briefly state the quintessence of it.

At that point of the tarsus skeleton where the proc. ant. calcanei, the cuboideum, the naviculare and the caput tali meet, without, however, all coming into direct touch, is to be found, with careful dissection, in a certain number of cases, a little bone of irregular shape, the so-called calcaneus secundarius; a tarsale which, previous to Pfitzner, Stieda (in 1869) and Gruber had already pointed out. Pfitzner found it on examination of 840 foot skeletons, which he had most minutely prepared, in nine feet as independent bone, *i.e.*, in about 1% of the cases, so that it is not so exceedingly rare. That it is so very rarely found in Röntgen examinations of the foot is due, I should say, to the projection in which the photos are generally taken, as, when the exposure is not particularly adapted to the position of this bone, it is covered by the neighboring bones. Like all the genuine rudimentary tarsalia, it appears symmetrically; in so far as when it is present, it always seems to be present in both feet; but the symmetry is veiled inasmuch as its size, independence, etc., can be very different in the two feet. Its size can vary greatly; Pfitzner found the largest specimen of it, measuring 15 x 8 x 5 mm., in an Egyptian mummy. On such specimens can be pointed out four surfaces facing the four bones mentioned, among which the calc. sec. is inserted. The surfaces facing the

talus and cuboideum are articular surfaces, while those facing the proc. ant. calcanei and the naviculare are attached to these bones by a fibrous tissue (identical with the calcaneo-navicular segment of the lig. bifurcatum S. ypsiloides). If the calcaneus secundarius is strongly developed, it, in this way, forms a bridge between the calcaneus and naviculare, and if now it follows the tendency of the inconstant tarsalia to fuse with the constant neighboring bones, it may show itself either, as is most usual, as a protuberance on the calcaneus, or as a protuberance on the naviculare, *or finally, if it attaches itself closely to both, as a coalitio calcaneo-navicularis.**

Of such coalitions Pfitzner has himself described 15, while he has collected 38 from the literature on the subject. The coalition may have the character of a complete synostosis; more frequently is found, between the two bones, a minimal, irregular shaped fissure filled with connective tissue; lastly, the connection may form a tight articulation.

After the number of cases of such coalitio calcaneo-navicularis, over fifty, which, as stated, Pfitzner has at his disposal and which, indeed, all are found by anatomical preparation, one might now expect that, with the era of Röntgen examination, new life would have been infused into the study of this abnormality, as now the clinical observation is in a position to make its contribution thereto. Nevertheless, this has hitherto been so far from the case, that I cannot recollect ever having seen an instance of this kind referred to or mentioned in modern orthopædic literature. The only such place I have found the abnormality mentioned is in Joachimsthal's large "Handbuch der Orthopädischen Chirurgie," where Joachimsthal himself, in the section on the ætiology of flat-foot (Vol. II, p. 668), mentions Holl's observation, but erroneously reports it as though it was concerned with a coalescence of the Calcaneus *and Talus.* It is all the more remarkable, that since my first case, described above, I have myself, in a very modest sphere of activity, met with three† cases more of the same kind;—cases which like the first, I have been able to study only through the most beautiful, but in comparison with the direct anatomical examination, highly imperfect method of the Röntgen examination; but which nevertheless may be acknowledged as unquestionable coalitiones calcaneo-naviculares. I shall show some illustrations of these cases.

My Case No. 2 was a boy of thirteen, who only in the last six

* According to Pfitzner, every such coalitio will involve also a cubodeum secundarium, a hypothetical tarsale, never observed as independent bone; a question which, however, would lead us too far if entered upon here.

† And now four.

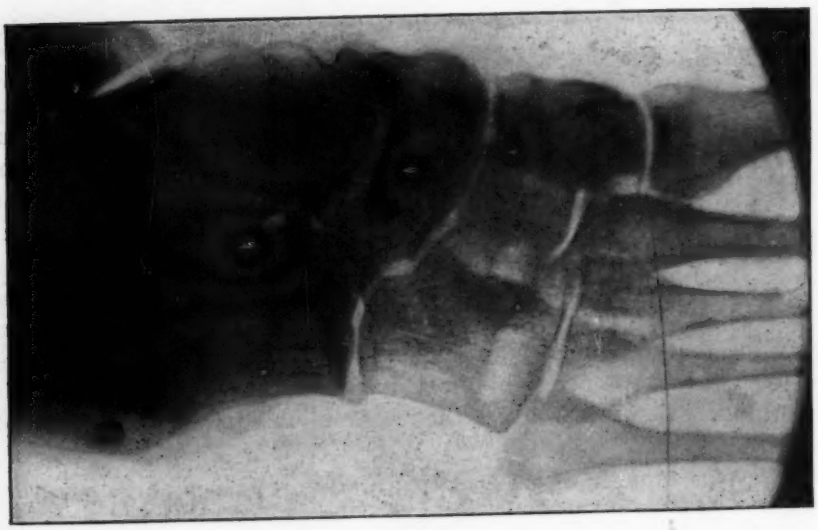

Fig. 13.

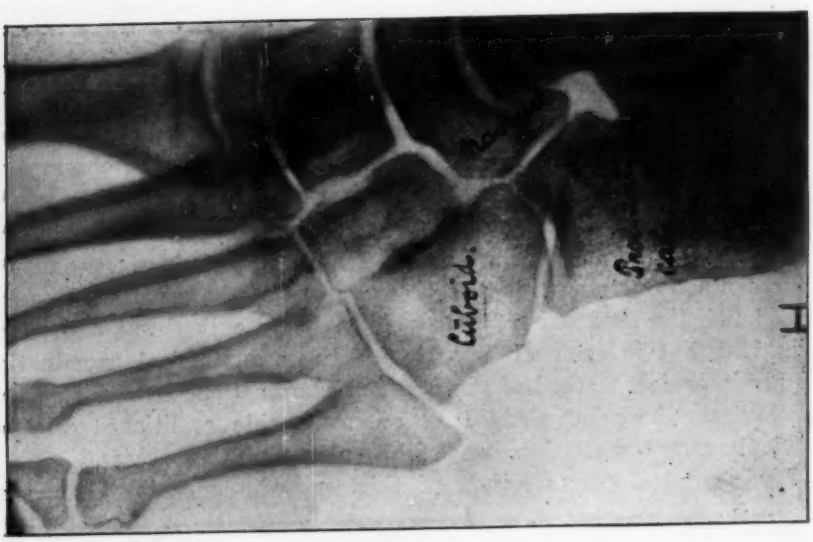

Fig. 14.

FIG. 15.

FIG. 16.

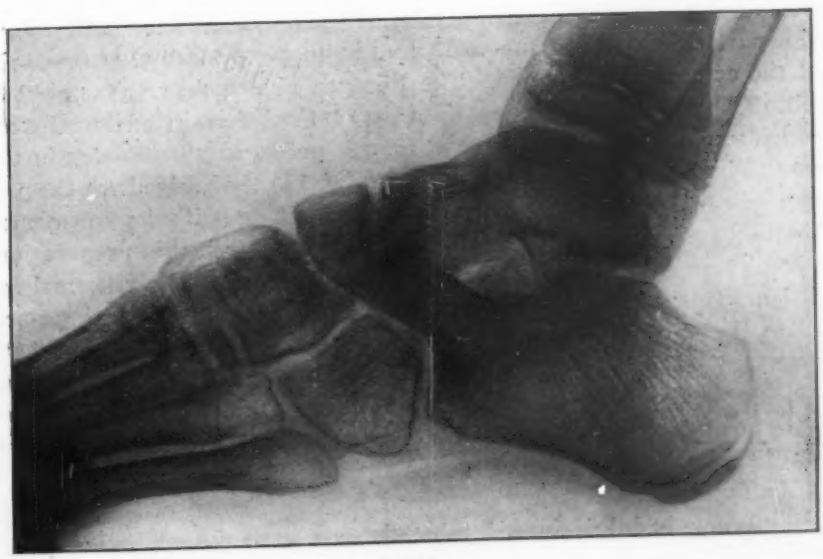

FIG. 17.

months had had pains in the left foot and crus, particularly after walking for some time. The left foot was a rather strongly applanated, but in no way remarkably deformed flat foot. The only thing remarkable, considering his age, was the unusual rigidity of the foot, which did not disappear with lying in bed and the application of cataplasms. The Röntgen photo (Fig. 5) shows an indubitable, though perhaps not yet completely ossified coalition, which also in the lateral view (Fig. 6) stands out very characteristically. The talus presents nothing particularly remarkable nor does the cuboideum. Especially interesting, from a clinical point of view, is the lateral picture of the quite normal right foot (Fig. 7). The remarkably strong and beautifully shaped prolongation, which from the proc. ant. calcanei extends up to the naviculare, represents very probably an os calcaneum secundarium fused with the calcaneus.

The third case has to do with a young girl of seventeen who, at the age of one year was pronounced to have flat-foot. At the age of ten, considerable pain and aching were perceptible, though only in the right foot, but which during the last few years had. if anything, diminished slightly. The shape of the foot, however, now became so unsightly that she took advice regarding it. Whilst the left foot is only a moderately applanated, flexible flat foot, the right, as you see (Fig. 8) is completely applanated and strongly valgus-deformed (Fig. 9), of a somewhat monstrous appearance, and besides completely stiff. There is a partial atrophy of the calf and, as in my first case, a shortening of the extremity of 1½ cm. The Röntgen photos show the typical coalitio (Fig. 10) and here, just as in Case 1, the deformity of the talus and cuboideum is rather considerable, though not so considerable as in that case (Fig. 11). In the lateral aspect (Fig. 11) the bridge from the proc. ant. calcanei to the navicularis is very striking with its conspicuous length (a circumstance which Holl also mentions in his preparation). The picture of the left foot seen from above, shows a fairly normal condition. In the lateral view (Fig. 12) is to be seen an interesting parallel to the normal foot in the foregoing case, an approach between the proc. ant. calcanei and the naviculare; but here it is the naviculare, which extends a curious prolongation downward and backwards, a prolongation which must be assumed to represent the calcaneum secundarium, here coalesced with the naviculare alone.

My fourth case I ultimately found in a gentleman of 59, who from his infancy had had considerable flat-foot troubles in both his now greatly deformed and perfectly stiff feet, severer, however, in the more seriously deformed left, which had once been treated with plaster of

Paris bandages. This case presents a special feature of interest inasmuch as it is, also as regards the anatomical abnormality, bilateral. As regards the left foot, the coalition is indeed typical both in the lateral aspect and in the dorso-plantar (Fig. 13). In the latter, however, a small irregular fissure can be faintly discerned on the plate which, nearly in the longitudinal axis of the foot, forms a boundary between the naviculare and the proc. ant. calcanei and which, I take it, is undoubtedly filled with a short, tight connective tissue which unites the bones immovably with each other. The "S" shaped articular surface in front is quite unbroken. As regards the right foot, the lateral aspect, at any rate, reminds one forcibly of that produced by the typical coalition. In the dorso-plantar picture (Fig. 14) is seen a broad contact between the naviculare and the proc. ant. calcanei, whereby the cuboideum is pushed far away from the caput tali, but between the two former bones, however, there is very distinctly seen so broad a fissure with so smooth an edge, that it evidently points more to an articulation than to a fibrous coalition. If one, however, observes the shapes of the two bones which here, indeed, are just the same as in the typical cases of coalition, and when one recollects *that under normal anatomical conditions the naviculare and the proc. ant. calcanei do not come into direct touch at all with each other*, it is then clear that here the conditions in the right and left foot are so closely related, that the case must be regarded as bilateral.

Of my cases, therefore, two are in the right, one in the left,* and one in both feet. Pfitzner finds on collocating twenty-one cases, two right, four left (of which one is with articulation), and fifteen in both feet (of which two are with articulation in both feet, one with articulation in the right foot). The abnormality, therefore, does not appear to show any particular preference for the right or left foot; according to the anatomical investigations, the cases are by a large majority bilateral. As you have seen, all my cases have had to do with severe flat-foot deformities, and flat-foot, both in regard to the degree of deformity as well as to the clinical symptoms, has been most severe in the foot where the anatomical abnormality was present or most pronounced. (In Case No. 2, that of a young boy of thirteen, the other foot was still normal both in build and function.) This coincidence cannot be accidental, any more than that, in spite of the most rigid attention, I have never met with the coalition as an accidental discovery in any of the very numerous cases where the foot skeletons of normally shaped and functioning feet have been examined with

* My fifth case, observed later, is also a left-foot case.

x-rays. Holl also, as mentioned, places the abnormality in close relation with a strongly pronounced flat foot deformity, which was present in his two cases. All the more remarkable is it then that Pfitzner flatly denies such a relation. His most pronounced case of coalition was, he says, found in a particularly well arched foot, and on the whole, in his 15 cases, he only twice found flat foot "mittleren Grades."

I am not in a position to give any explanation of this disagreement; the deformities which were present in my cases could not fail to be seen even by an anatomist, and the relation of the coalition to the deformity is, in my opinion, unquestionable.

It is, I take it, the manner in which the anterior component of the body weight, acting downward and forward in the corpus tali, is transmitted through the caput tali to the naviculare *and then stopped up by the coalition,* is transferred directly to the foremost and innermost point of the calcaneus (instead of, as in normal conditions, to be transmitted from the naviculare forward through the cuneiforme I to the metatarsale I), which rotates the calcaneus inward and lays its foremost part down flat against the ground. My Case No. 1, in which the back end of the metatarsale I was depressed and the front end tipped upward, appears to me in this respect to be particularly instructive.

In the performance of Chopart's operation, the presence of the abnormality will form an apparently insurmountable and, for those who do not know it, an incomprehensible obstacle.

I cannot conclude this statement without saying a few words as to *the treatment* of these cases. I have in the three cases, where young persons of 13, 16 and 17 years of age were concerned, treated them just as I treat all other cases of flat foot deformities at that age, with moulding and fixing in plaster of Paris in corrected or over-corrected shape and position; after that, working up of the mobility and muscular power, corrective night bandages and flat-foot boots (or Whitman's metal soles in the boots). The primary result has been fairly satisfactory. While my first, monstrous case could only be corrected to a certain extent, I was in this respect very successful with the other two patients. I can show you the result in Case No. 3, that of the 17-year-old girl, whose foot, before treatment, is shown, laterally, in Figure 8. Figure 15 shows the change that took place after treatment (the scar is due to a transplanting of the tibialis anticus from the dorsal side of the foot, where it was inserted, down to the plantar side of the basis metatarsi I). Figure 9 shows a posterior view of the

foot before treatment, and Figure 16 the same view after treatment. The good result, both as regards shape and function, in this case, has now lasted for a year; but I must say that I myself have not much confidence in the durability of the results of this method; for the deforming factor which I have mentioned above, the body weight's direct downward pressure on the proc. ant. calcanei, of course, continues to exist. I have also considered the possibility of a surgical operation for removing the coalition, that is to say a resection of the abnormal bridge between the calcaneus and naviculare. The reason why I have hitherto refrained from performing this operation is that the consequences of the looseness in the tarsus caused thereby are difficult to overlook; for of course such a resection cannot create a normal condition between the two bones: the normal ligamentous connection is wanting; and the tarsus, we must suppose, is also the seat of other ligamentous and muscular deficiencies which are not removed by the coalition ceasing to exist. Should, however, such a case come to me with a severe relapse after the first more conservative treatment, and with great subjective difficulties, I would, nevertheless, seriously consider such an operation.

Since the conclusion of the above article, I have had the opportunity of seeing still another case of the same kind.

N. L., a bright, healthy little girl of ten, was admitted into my clinic in August, 1920. Her left foot was always disposed to be tender, though her gait was natural and she was a good walker. Ten or twelve days ago when, after a drive, she attempted to walk on alighting from the motor-car, she suddenly felt severe pains in that foot, which also, on her arrival home, appeared swollen, and the pains increased in spite of rest and massage. When she was examined by me the swelling had disappeared, but there was a distinct tenderness around the foot, corresponding to Chopart's joint line, most severe on the lateral side and in the planta. The shape and arch of the foot was perfectly normal—it was, if anything, unusually well formed—but she refused to stand on it on account of the pain. Röntgen plate showed a typical coalitio calcaneo-navicularis (Fig. 17). The right foot was of the same good shape and entirely free from pain; Röntgen photo here showed a perfectly normal condition.

There was a reduction in circumference of 1 cm. of the left leg, both about the crus and femur, but no shortening of the limb.

After the foot had been set in plaster of Paris for a week and had received later massage treatment, and a support for the instep fitted into the boot, the symptoms for the present have disappeared.

The particular feature of interest in this case lies, for the one part, in the still well preserved shape of the foot; and for the other, in the functional insufficiency connected with the abnormally constructed foot skeleton, which, nevertheless, even now is conspicuous, and which, if the instep is not mechanically supported, will undoubtedly lead to serious functional disturbances and flat-foot deformity.

BONE SARCOMA. AN ANALYSIS OF THE CASES ADMITTED TO THE MASSACHUSETTS GENERAL AND COLLIS P. HUNTINGTON MEMORIAL HOSPITALS FROM JANUARY 1, 1911, to JANUARY 1, 1921.*

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In view of the interest in this subject aroused by Dr. E. A. Codman's move to organize a registry of living cases, and with due regard to the lack of coördination of opinion upon the pathological and clinical aspects of bone sarcoma, the writers have collected and studied the cases of sarcoma of bone from the records of the Massachusetts General Hospital and the Collis P. Huntington Memorial Hospital for a ten-year period ending January 1, 1921.

The records of both hospitals were examined, and all cases entered with a provisional diagnosis of bone sarcoma were examined, 148 in number, together with 27 cases of bone-cyst, osteitis-fibrosa, and epulis, which were desired for comparative study—a total of 175 cases examined.

Perhaps the most surprising fact of the whole study is that out of 148 cases sent in as possible bone sarcoma only 66 could be considered in fact to be cases of malignant new-growth of bony origin; the remaining 82 cases proving on more detailed study to be metastatic tumors of bone (29 cases), sarcoma primary in the soft parts (28 cases),

* Presented at a meeting of the American Orthopedic Association, Boston, Massachusetts, June 2, 1921.

inflammatory conditions (11 cases), or tumors of a non-sarcomatous type (14 cases).

Cases of sarcoma of antrum, ethmoid and accessory nasal sinuses, eight in number, are included in the group of cases of sacoma of the soft parts. Although bone involvement occurs early in these regions, no evidence could be obtained to justify the idea that these were tumors of bone origin or included osteogenic tissue.

Of the 66 tumors of bony origin, 15 were probably cases of bone sarcoma, but as no operation was performed and pathological proof of the nature of the disease was not available, these cases have been discarded as of no value in this investigation. Six cases of probable multiple myeloma were also omitted from consideration for lack of pathological evidence to support the diagnosis and two cases of a true bone sarcoma could not be traced after discharge from the hospital and are, therefore, eliminated as inconclusive. Taking these 23 cases out, the remaining 43 cases have been studied to supply the data for this report.

While more elaborate classifications of bone sarcoma have been offered, notably by Borst, Bloodgood and Buerger, the classification given by Ewing in his book "Neoplastic Diseases" has been followed in this investigation. Under Ewing's classification, the 43 cases studied may be grouped as follows:

1.	Osteogenic Sarcoma	27	cases
2.	Benign Giant-cell Tumors	12	"
3.	Myeloma	3	"
4.	Angio-endothelioma	1	case
	TOTAL	43	cases

It will be observed that the largest group, 27 cases, falls under the general classification of osteogenic sarcoma. Ewing distinguishes three types under the heading: (a) sclerosing; (b) telangiectatic; (c) fibro-cellular (chiefly periosteal).

We have one example of the sclerosing type, none of the telangiectatic variety, and 26 of the fibro-cellular group.

The difficulty of classification of these tumors appears to be due chiefly to the attempt to apply to bone sarcoma the distinctions in regard to histology which are commonly employed in the study and nomenclature of tumors and diseases of other tissues. Thus spindle-cell sarcoma, large round-cell and small round-cell sarcoma, fibro-sarcoma, myxo-sarcoma, chondro-sarcoma, osteo-sarcoma, osteoid-sarcoma, and combinations of these terms, such as osteo-chrondro-sar-

coma, fibro-myxo-sarcoma, are all terms which have been used rather indiscriminately by surgeons and by pathologists with the effect of clouding the issue rather than of contributing to our knowledge of the disease. The attempt to distinguish also between central or medullary types of sarcoma and those of periosteal origin has also added to the difficulties of the subject, and although certain forms of tumor, such as the "benign giant cell tumor," are essentially central in origin when they occur in the long bones, in other situations they may be situated outside the bone and attributable only to a periosteal origin, as in their commonest manifestation, the true epulis of the alveolar process of the jaw.

As a result of our study of the pathological material of this series of cases, together with the x-ray plates, and with the assistance and advice which we gratefully acknowledge to have received from Dr. James Homer Wright, Dr. James Ewing, Dr. Henry F. Hartwell, Dr. E. A. Codman, and Dr. George W. Holmes, we have been driven to the following conclusions:

The osteogenic sarcomatous tumors which arise in bone substance are produced by a tumor growth of the essential fibrous tissue made up of spindle cells, which is the accepted progenitor of the bone-forming tissues of the body. These cells are capable of differentiation into bone, osteoid tissue, cartilage, myxomatous tissue, and fibrous tissue, as well as into a more succulent and less differentiated mass of pleomorphic cells of irregular form and function, and of high malignancy. In cases of the pleo-morphic and highly malignant type, giant cells of tumor origin similar to the epithelial giant cells of cancer, and containing two, or occasionally more, large, irregular nuclei often in mitosis, are sometimes found. These tumor giant cells are to be distinguished sharply from the typical foreign-body cells of endothelial origin (Mallory; Barrie) which are encountered so frequently in all bone diseases, benign and malignant, and which are of practically no significance from the tumor point of view, however much they may impress themselves upon the observer in the microscopic sections of the tissue, as in the miscalled "giant cell sarcoma" of the epulis type, which is, in fact, as it has been abundantly proved by Bloodgood and others, a non-malignant and non-metastasizing tumor.

With this preliminary statement we may proceed to an analysis of the four types of bone sarcoma which were available to us for study:

OSTEOGENIC SARCOMA.

Twenty-seven cases. The ages at which tumors of this character occur cover a considerable period of life. By decades there were:

1 case from 1 to 10 years
9 cases from 10 to 20 years
7 cases from 20 to 30 years
4 cases from 30 to 40 years
6 cases over 40 years

The greatest incidence is thus seen to be between 10 and 30, and in earlier and later ages the disease is less common, although it does occasionally occur.

In any study of malignant disease the duration of the symptoms before radical operative treatment is afforded is of the utmost significance. In this series the duration of symptoms was less than twelve months in all but three cases; from one to three months, eight cases; three to six months, eight cases; six to twelve months, eight cases; over twelve months, two cases, and doubtful, one case. This must be admitted to be a fairly prompt application of radical measures, but the results appear to indicate that the delay in procuring radical treatment is still too long.

Thirteen cases gave pain as the first symptom, and four stated that pain and swelling began together. Nine cases noticed a swelling tumor as the first symptom, and in one case a spontaneous fracture was the first symptom to draw attention to the condition. It is significant, apparently, that pain may precede the obvious development of the tumor for a considerable period of time. In 10 of the 27 cases a positive and definite history of local trauma of some sort was given as a matter of significance in the history, and usually at a period but slightly prior to the onset of symptoms. We believe it possible that the element of trauma may well enter into the question of the etiology of these tumors.

Twenty-two cases in this group involved the long bones—femur 10, tibia 9, humerus 2, fibula 1. Two involved the lower jaw, one the spine, one the pelvis, and one the ribs.

Operation.

Nineteen amputations were performed when the disease was in the long bones, and an amputation was a possibility, and in two cases amputation was advised and refused.

One case, a boy of twelve, died within twenty-four hours of operation as a result of shock and hemorrhage. This was a patient with a large tumor springing from the base of the skull, filling the ethmoid and antral region and infiltrating the upper jaw, so that it extended into the zygomatic fossa. The tumor was of osteogenic fibro-myxomatous type, and was believed to be one of low-grade malignancy, but its local extent involved too severe an operation for the resistance of the patient. This was the only operative death.

In 15 of the 27 cases an exploratory incision was made to procure tissue for pathological examination. In four cases the records were not clear upon this point, and in eight cases no exploration was made. It is suggestive that in two of the five successful cases exploratory incision into the tumor was made at some time prior to the radical operation, and in one other case an incision was made into the tumor, the diagnosis established, and the amputation at once performed. It does not seem unreasonable, therefore, to maintain that an exploratory incision diminishes but little, if at all, the patient's chances of cure by radical operation. We would not be understood to advocate exploration as a routine measure, but if the diagnosis is uncertain after x-rays and other methods of examination have been employed, a carefully conducted exploration, making use of formalin or carbolic packs, or the actual cautery, and discarding the instruments and dry goods used, before proceeding to immediate amputation, seems to us to be preferred to the misfortunes of either a needless amputation of an extremity, or of delay until the condition is beyond operative relief.

Non-operative Treatment.

In those cases which refused radical treatment by excision or amputation, and in a number of cases in which the radical operation was performed, treatment by x-ray or with Coley serum was employed as a curative or prophylactic measure. In no case of this series was radium treatment given.

Coley serum was used systematically in three of these cases by Dr. Harmer, and with no obvious benefit; and in one other case Coley treatment was given after operation by the physician in charge of the patient, at his home. None of these four patients lived more than ten months after operation.

So far as the non-operative methods of treatment of osteogenic sarcoma go, this series gives but little information.

Pathology.

The most interesting feature of these tumors, apart from the seriousness of the disease and the small percentage of cases which are relieved by operation, is the gross and microscopic pathology of the tumors.

The routine pathological examination of the material of the two hospitals was under the direction of Drs. J. Homer Wright, W. F. Whitney and H. F. Hartwell, and their reports have been taken in extenso, but the slides have all been re-studied and in several cases new sections have been cut and stained. All of the material has been reviewed by Dr. Wright.

As has already been stated, it is our belief that a differentiation of these tumors into many groups, according to the various cell types or tissue types observed, tends somwhat to confuse the issue. The cell characteristics of a high degree of malignancy in other tumors are well recognized and depend upon such elements as irregular and distorted nuclei, hyperchromatism, marked variation in the size, shape, and staining qualities of the cells and the occurrence of "tumor" giant-cells—cells containing a relatively small number of irregular nuclei, irregularly placed in the cell, and almost always readily distinguished from the huge typical "foreign-body" giant cells that occur in bone tumors and complicate the picture. The essential tissue from which these tumors are derived is the fibrous tissue, made up of spindle cells (fibro-blasts) which is the progenitor of bone. These cells are capable of differentiation into cells of many forms, and of producing intercellular substance varying from fibrous tissue through myxomatous-like substances to osteoid tissue, cartilage, and bone. This differentiation is a fundamental characteristic of these cells and although often incomplete and atypical, almost invariably can be recognized even in the most irregular and rapidly growing types of tumor in which pleo-morphic growth is most conspicuous.

Thus, in this series of 27 cases, fibrous tissue cells and substance could be identified in every case. In 24 cases osteoid tissue could be recognized. In 11 of the above 14, cartilage was present, and in five cases myxomatous tissue was found, usually but not invariably accompanying cartilage. In three of these cases large "epulis" type foreign-body giant-cells were a conspicuous feature of the tumor, but were accompanied by osteogenic tumor tissue of such a degree of active growth that the failure to obtain a cure in any of these three cases was not difficult to understand.

Reference will be made to these facts in the discussion of the end-results, but it is sufficient here to say that the character of the cell growth in form, size, shape, and regularity, as shown by the microscopic examination rather than the intercellular substance which may be differentiated from them, appears to us to be the important fact in determining prognosis.

Of the three types of osteogenic sarcoma distinguished by Ewing, two are here represented (Case 123). There was one example of the "sclerosing" type of osteogenic sarcoma. This was a woman of thirty-four who for twelve months had had a fusiform swelling of the thigh just above the knee, following an injury. X-rays showed a dense mass of cortical bone in the lower end of the shaft of the femur and the radiating lines of bone trabeculae outside the cortex characteristic of periosteal sarcoma. An exploratory incision was made and the leg was amputated. The specimen showed a dense new growth of bone, the cortex of the femur being 2 cm. thick, and the interstices of the bone trabeculae filled with tumor tissue of a fibro-osteo-sarcoma type. The picture was one of a high degree of differentiation in the way of bone formation and of low malignancy. There were few mitoses. The patient is well at the present time—three years after operation.

Of the telangiectatic type (Ewing) we have no examples, and the remaining 26 cases fall into the fibro-cellular osteogenic sarcoma group. It is probable that some of these tumors are of endosteal rather than periosteal origin. At any rate, fibro-cellular osteogenic sarcoma is the safest and most accurate term to use.

X-ray.

While the x-ray is, without doubt, the most valuable method we possess for arriving at an idea of the structural changes of all bone lesions, we must not forget that its lights and shadows must be interpreted with a full knowledge of the anatomical and physical conditions, and especially of the density or atomic weights of the varying substances.

With the x-ray we can determine the absence of bone where bone should be, and its presence where it should not be, but osteoid tissue and cartilage throw no such shadow as bone, and their presence is not so readily demonstrated. Again, the absence of normal bone shadow may be due to a great number of pathological processes—developmental, inflammatory, and constitutional—as well as to a large number of malignant tumors of which bone sarcoma is only one va-

riety. It is a suggestive fact that in collecting 27 cases of osteogenic sarcoma, 29 cases of metastatic tumors of bone had to be eliminated as well as 28 cases of sarcoma originating in the soft parts, and subsequently invading the bone.

Under the circumstances it is perhaps not unnatural that the x-ray is not always an absolute method of diagnosis. The arbitrary distinction between central (or medullary) and periosteal sarcoma is also a cause for difficulty in x-ray interpretation, although the benign giant cell tumor has certain pronounced and positive characteristics by which its x-ray picture can often be identified.

The x-ray plate of an osteogenic sarcoma is not always characteristic. A well-defined tumor of the cortex of one of the long bones showing increased density within and without the marrow cavity, radiating lines of new bone formation perpendicular and external to the cortex, elevation of the periosteum at the edge of the tumor, and with areas of bone destruction, is the generally recognized picture of typical periosteal osteogenic sarcoma. Fourteen of this series of 28 cases were of this variety. In two cases a process of bone destruction with but little new bone formation was shown in the x-ray (easily mistaken for metastatic cancer or osteomyelitis), and in four cases the tumor was apparently central in origin, and no obvious new growth of bone, beyond the cortex, could be made out. The resemblance to a giant cell tumor in these cases is very marked. In the other seven cases the x-ray plates were inconclusive or were not available for reëxamination.

In general it can be said that in its earliest stages the x-ray of an osteogenic tumor shows an area of increased density either within or without the bone. As time goes on and the normal bone is absorbed and replaced by less differentiated cells, defects in the bone substance appear, their degree of emptiness depending upon the amount of density of the tumor tissue. At the same time a distortion of the external surface of the bone appears, again depending upon the density of tumor growth outside the cortex. It is easy to see that any metastatic tumor, whether derived from a hypernephroma, a neuro-blastoma or a cancer of the prostate or of the breast, may simulate this picture very closely, and although the diffuse growth of new bone in spicules perpendicular to the cortex is only rarely duplicated in any other condition than osteogenic sarcoma, it is not by any means a constant phenomenon of that disease, and its absence is not sufficient to rule out that condition.

End-Results.

In other publications dealing with the end-results of operations for cancer of the breast and cancer of the tongue and mouth,* the writers have attempted to establish a standard method of reporting cases in order that the results of different clinics may fairly be compared. A tabular statement of these cases on this standard form is as follows:

OSTEOGENIC SARCOMA.

A.	Total cases entered hospitals	56
B.	Re-entries	12
C.	Recurrence from previous operations (not eliminated in this series)	0
D.	Cases without pathological report or evidence to support diagnosis	0
E.	Untraced	2
F.	Inconclusive (arbitrary three-year limit not attained)	2
G.	Remainder, traced	40
H.	Radical operations { Amputation ..... 17 / Excision or resection 6 }	23
I.	Palliative operations (explorations only)	2
J.	No operation	15
K.	Operative deaths	1
L.	Operative mortality	4%
M.	Operability percentage—all cases	66%
N.	Operability percentage—radical operations	58%
O.	Number of cases alive and well (3 years)	2
P.	Number of cases died without recurrence (3 years+)	1
Q.	Total 3 year "cures" by radical operation (Cases Nos. 12, 28, 44)	3
R.	Total 3 year "cures" all operations	3
S.	Percentage of "cures" by radical operation	13%
T.	Percentage of "cures" by all operations	12%

Thus of the 27 cases of osteogenic sarcoma we must eliminate two which are alive and well at periods of twelve and fifteen months after operation, on the ground that they have not reached the arbitrary three-year limit. Of the remaining 25 cases, 23 had radical operations performed in the hope of cure, and two refused operation. Seventeen were amputations and six were excisions or resections, as of the jaw, ribs, pelvis, spine, etc. The 23 radical operations yielded one operative death (4.3%), and three cases free from disease at the expiration of the three-year limit. We hesitate to call them cures. This gives a percentage of success by radical operation of 13 per cent.

The three successful cases are as follows:

CASE 12. Aged 34. Twelve months' duration. Femur. X-ray: periosteal trabeculae and dense tumor. Sclerosing type osteogenic sarcoma. Amputation. Well. Three years.

CASE 28. Aged 24. Six months' duration. Tibia. X-ray: "periosteal" sarcoma. Osteogenic-fibro-osteo-myxo-sarcoma. Ampu-

* End-results in cancer cases. Greenough and Simmons. Boston Medical and Surgical Journal, Vol. 185, No. 9, pp. 258-261, Sept. 1, 1921.

tation. Remained free from disease and was examined by physician in five years, but died of acute influenza-pneumonia during the epidemic, five and a half years after operation.

CASE 44. Aged 65. Two and a half months' duration. Jaw. X-ray not recorded. Osteogenic-fibro-osteo-sarcoma, central and peripheral. Resection. Well, three years.

The remaining 22 cases are all dead or when last reported had positive recurrence of the disease. The average duration of life after operation in these cases was eleven and a half months, the figures varying from immediate post-operative death to three and a quarter years. In no case did a recurrence develop at a period of time greater than three years after operation. The most frequent situation for recurrence was in the lung—the figures for 17 cases giving: lung alone, 9; lung and local, 3; lung and spine, 1; spine, 2; abdomen, 1; local alone, 1.

This completes the analysis of the cases of osteogenic sarcoma. A few cases (13 per cent.) have been successfully treated with radical operation, but the vast majority develop lung metastases and die within a short period.

BENIGN GIANT CELL SARCOMA.

The term "sarcoma" is a very doubtful one to apply to this group of tumors, and it should undoubtedly be taken from the sarcoma class and given another title, as suggested by Bloodgood and others. Benign giant cell tumor is, perhaps, as good as any.

Of this group we have 12 cases, and of these cases 11 are alive at periods of three months to eight years after operation, and there was one death following operation. This stands out in clear contrast to the group of osteogenic tumors.

Age.

The ages of these cases varied from twenty-eight months to sixty-eight years, with the following distribution in decades:

3 cases from 1 to 10 years
3 cases from 10 to 20 years
1 case from 20 to 30 years
2 cases from 30 to 40 years
2 cases from 40 to 50 years
0 cases from 50 to 60 years
1 case from 60 to 70 years

The incidence in youth and young adults is not so striking in this series as in other reported cases.

Symptoms.

The duration of symptoms varied from two days to three years and averaged about twelve months. The first symptom was swelling in six cases, pain in five cases, and a spontaneous fracture in one case. There was a definite history of trauma in three cases shortly prior to the development of symptoms.

Situation.

The 12 tumors of the benign giant cell type were widely distributed: Eight involved the long bones, as follows: femur, 2; tibia, 2; radius, humerus, fibula, and ulna, each 1. The other four involved other bones, as follows: phalanx, 1; upper jaw, 1; lower jaw, 1, and spine, 1. Seven involved the extremities of the long bones and only one the shaft.

Operation.

The operations performed in these 12 cases varied from incision and curettage to amputation. There were three cases of amputation, two of complete resection, and seven of incision, partial excision, and curettage. There was one operative death from pneumonia, following resection of the upper jaw, in a child of two years of age, for an enormous tumor which distended the antrum, perforated the zygomatic fossa and palate and produced exophthalmos. One case in this series received treatment by the insertion of radium needles after curettage. This case is now living, with recurrence, but the disease is retrogressing. Another case of tumor of the spine had only a partial excision, followed by recurrence. This case was given Coley treatment under Dr. Harmer, for seven months, with injections directly into the tumor, which became necrotic and sloughed away. A tumor developing subsequently was excised and showed no evidence of the original growth. The patient is now well eight years after the original operation. In all but four of the twelve cases a preliminary incision for diagnosis was performed.

Pathology.

The characteristics of the benign giant cell tumor are well recognized and have been described by Bloodgood and others. The tumor is of central origin, as a rule, and effects especially the ends of the long bones, extending frequently across the epiphyseal line. It especially affects young adults, although in this series, cases of all ages have been encountered. The growth from within thins the cortex and

complete or partial fracture of the cortex may occur with spontaneous fracture (one case) or extension to the soft parts. This may be so extensive that conservative measures are impossible and amputation is the only resource, but, as a rule, more conservative treatment is possible and should be attempted.

The gross appearance of the tumor is characteristic—a dark, succulent, friable tissue fills the dilated interspaces of the bony shell. On microscopic examination this tissue is made up of fibrous tissue spindle cells of fairly constant form and character, but interspersed with large numbers of the characteristic large foreign-body giant cells which dominate the microscopic picture. The tissue is similar in every way to that of the true epulis of the gums, and is often spoken of as of the "epulis" type. We have no evidence of any metastases from tumors of this type. Occasionally, however, other elements are found in tumors of the benign giant-cell group. These are areas of osteoid tissue and cartilage sufficient in some instances to suggest a new growth of these elements. On closer consideration, however, it is realized that opportunity for the formation of new bone and for the presence of cartilage is afforded by the destructive process which thins the cortex, and the involvement of the epiphyseal line in which growing bone and cartilage are already present. We are inclined to believe that this is the explanation for the apparently new-formed bone elements occasionally but infrequently discovered in microscopic sections of benign giant cell tumors.

X-rays.

The x-ray plate of a benign giant cell tumor has certain well defined diagnostic characteristics. The tumor occupies the central part of the bone, usually at the expanded end of one of the long bones, and produces an absorption of the finer bone trabeculae, leaving clear spaces of diminished density, more or less divided into several chambers by the bony trabeculae which are sufficiently solid to resist absorption. The whole cortex becomes thinned and expanded, and in advanced cases may be fractured or perforated, and the tumor may extend into the soft parts. The tumor often extends across the epiphyseal line to the joint cartilage, but the joint was not involved in any case of this series.

The extension beyond the epiphyseal line is a point in diagnosis which distinguishes from bone cysts, which occur, as a rule, in younger children. In other respects the x-ray pictures of the two conditions are very similar. In none of our cases was there x-ray evidence of

new bone formation, although in four cases areas of osteoid tissue were recognizable in the microscopic section of the tumor. Two of these cases were tumors of the long bones involving the epiphyseal ends, in children thirteen years of age. The third was a case of spontaneous fracture, and the fourth was a tumor of the lower jaw.

Diagnosis.

The benign giant cell tumor is to be distinguished especially from the benign conditions such as bone cysts and osteitis fibrosa as well as from the osteogenic tumors. Some of the metastatic bone tumors—cancer, hypernephroma, etc.,—can also closely simulate the x-ray picture of a benign giant cell tumor, and these conditions must be recognized either by the discovery of multiple tumors or of the primary lesion, or by an exploration. Some of the more chronic inflammatory conditions—osteomyelitis, tuberculosis and syphilis—may also be confused with the benign giant cell tumor by x-ray alone, but almost always show some evidence of the new bone formation which is characteristic of the inflammatory processes. The tendency of the benign giant cell tumor to overrun the epiphysis, as well as the greater age of the patient, is an aid in excluding bone cysts, and from some of the less differentiated and more malignant osteogenic tumors the diagnosis can be made with certainty only by an exploration.

End-Results.

The end-results of benign giant cell tumors can be arranged in the following table in the same manner as the cases of osteogenic sarcoma, and the results are notably different.

BENIGN GIANT CELL SARCOMA.

A.	Total cases entered hospitals	14
B.	Re-entries	2
C.	Recurrence from previous operation (not eliminated)	0
D.	Cases without pathological report or evidence to support diagnosis	0
E.	Untraced	0
F.	Inconclusive (arbitrary 3 year limit not attained)	2
G.	Remainder, traced	10
H.	Radical operations { Amputations 3 / Resections 2 }	5
I.	Palliative operations (explorations only)	5
J.	No operation	0
K.	Operative deaths	1
L.	Operative mortality	10%
M.	Operability percentage—all cases	100%
N.	Operability percentage—radical operations	50%
O.	Number of cases alive and well (3 years)	8
P.	Number of cases died without recurrence (3 years+)	0
Q.	Total 3 year "cures" by radical operation	5
R.	Total 3 year "cures" all operations	8
S.	Percentage of "cures" by radical operation	100%
T.	Percentage of "cures" by all operations	80%

With the exception of the one patient that died of pneumonia after operation, all of the cases are living, and in only one case is there at present evidence of disease. The length of time following operation in two cases is only six months, and these two cases, therefore, have to be rejected. Of the remaining nine cases which survived operation, eight are free from disease at periods of time from four to ten years after operation. It would seem that no further evidence was needed to support the claim that the benign giant cell tumor is a local, non-metastasizing tumor, and that its removal or destruction is sufficient to produce a cure.

One case, number six, a benign giant cell tumor of the spine, received treatment with the Coley toxins directly into the tumor mass. One other case received treatment by radium after a partial excision. This is a recent case, however, and the x-ray still shows evidence of disease, although it is not extending. In none of the cases of this series could data in regard to x-ray treatment be obtained, but it is safe to say that no systematic series of x-ray treatments was given in any case.

ANGIO-SARCOMA.

There was one case in this series of angio-sarcoma of the ilium. These tumors are distinguished by Ewing as a special group of tumors of bony origin. The case was as follows:

CASE 17. A woman of sixty years had had pain in the left hip for seven months. A local examination showed a mass in the region of the left ilium. The x-ray showed a destructive process involving the ilium in the region of the left sacro-iliac joint. An exploratory operation was performed, and tissue removed for examination, which showed a tissue made up of new formed blood-vessels and containing trabeculae of bone. It could not be stated whether or not this bone was of new formation, and it is not at all impossible that it was the older trabeculae of the ilium which had resisted absorption longer than the rest of the tissue. No further treatment was given and the patient died in about six months.

MYELOMA.

Nine cases of myeloma were recorded in the hospital records during the ten-year period. Six of these cases, however, were cases of multi-

ple myeloma with characteristic symptoms, and no operative measures were undertaken, so that the positive microscopic proof of the disease was not available. Three cases came into the surgical wards, as follows:

CASE 11. A man of fifty-five years, who for two years had had a gradually increasing tumor of the right ilium. The x-ray showed a definite pathological process involving that bone, the nature of which could not be determined. An exploratory operation was performed and tissue was removed for examination. The patient, however, was in very poor condition and died of hemorrhage two days later. There was no autopsy. The examination of the tissue showed a typical plasma cell myeloma. No other focus of disease could be discovered on clinical examination.

CASE 20. A child of fifteen years. The child came to the hospital for an axillary abscess of two weeks' duration. X-ray examination showed an area in the upper two thirds of the humerus, with increased density and with scattered areas of diminished density. The case was regarded as one of osteomyelitis. Incision was made; no pus was found. The tissue removed suggested a myeloma. X-rays of the skull, spine, and of the long bones showed no other foci of disease. Bence-Jones bodies were absent. The second operation was performed and the diseased area was incised and curetted. The wound healed and the child was well four months later. The tissue removed showed the characteristic picture of a plasma cell myeloma.

CASE 52. A man of forty-eight years applied at the Eye and Ear Infirmary for treatment of exophthalmos. A tumor of the outer wall of the orbit was removed. Examination of the tissue showed a typical plasma cell myeloma, but no other evidence of disease was found by x-ray, and there were no Bence-Jones bodies. Following this operation there was some thickening of the tissues in the region of the orbit, and radium treatment was employed by deep filtration, for six months. At that time a second operation was performed, the eye was enucleated and the tissues of the orbit were widely excised. Six months later there was no evidence of disease in the orbit, but another tumor had developed in the upper jaw. This tumor was excised and the cavity packed with radium. Examination of the tissue showed the same plasma cell myeloma that had been found in the orbit. Nine months later a tumor developed in the lower jaw, which was curetted. It was necessary to repeat the curetting twice in the next four months. It is now two years and a half since the last operation and the patient remains well.

These three cases of myeloma are recorded because of their peculiar character. In only one of the three was there evidence of a multiple lesion and that in only two bones. The pathological examination of

the tissue in these cases was similar in every way to the cases of multiple plasma cell myeloma which have been described in the literature. The x-rays were not distinctive and showed only a destructive process which might be mistaken for osteomyelitis or metastatic malignant disease. In two cases, operative removal of the tissue was apparently successful in relieving the patient, although the time elapsed in these two cases—six months and two and a half years—is too short to be conclusive. Neither case received Coley treatment, but radium was used in one case, although the benefit from radium treatment was not conspicuous.

SUMMARY.

1. One hundred and forty-eight cases of supposedly bone sarcoma reviewed for a ten-year period yielded for study:

Osteogenetic Sarcoma	27 cases
Benign Giant Cell Tumor	12 cases
Angio-Sarcoma	1 case
Myeloma	3 cases

2. The classification of Ewing has been adopted and of the tumors of the osteogenic group three types are distinguished, of which, however, only two are available in this series:

Sclerosing type	1 case
Telangiectatic	0 case
Fibro-cellular	26 cases

3. *Etiology:* The history of trauma shortly preceding symptoms is more often obtained in cases of osteogenic sarcoma than in other classes of malignant disease (10 out of 27 cases).

4. *Symptoms:* Osteogenic sarcomata are more common in young adults, but occur at all ages. They affect more often the epiphyseal ends of the long bones, especially femur and tibia, but are found occasionally in other situations. The chief symptoms are pain and tumor. Spontaneous fracture may occur but is unusual.

5. *Diagnosis:* Errors in diagnosis are common and result from confusion of bone sarcoma with other diseases, as:

Osteomyelitis, syphilis and tuberculosis (11 cases).
Benign tumors and diseases of bone as bone cyst and osteitis fibrosa (15 cases); Paget's disease (1 case); enchondroma and osteoma (10 cases).
Sarcoma of soft parts invading bone (28 cases).
Metastatic tumors as carcinoma, hypernephroma, lymphoma, melano-sarcoma, angio-endothelioma, myo-sarcoma, etc. (20 cases).
Neuro-blastoma (9 cases).
Chordoma (1 case).

We have examples of all these lesions being confused with bone sarcoma.

6. *X-rays:* The typical x-ray picture of the common form of periosteal osteogenic sarcoma is well recognized. Fourteen of this series of 28 cases were of this variety. In two cases a process of bone destruction with but little new bone formation was shown in the x-ray, —easily mistaken for metastatic cancer or osteomyelitis. In five cases the tumor was apparently central in origin, and no obvious new growth of bone beyond the cortex could be made out. The resemblance to a giant cell tumor in these cases is very marked.

7. *Pathology:* The attempt to distinguish osteogenic sarcoma by the intercellular substance produced by the tumor cells, or to make a hard and fast distinction between those of periosteal or medullary origin, appears to us, at present, to lead to confusion. We believe that the microscopic characteristics of the fundamental tissue of origin, —the spindle cell fibroblasts which are the progenitors of the bone-forming tissue,—are the criteria on which the classification should be based. The degree of differentiation which this tissue undergoes into cartilage, bone, etc., is of less significance than the departure from normal of the cells.

8. *Treatment and Results:* Of 40 traced cases of osteogenic sarcoma, 23 had radical operative treatment, two had exploration only, and 15 were not operated upon. This gives an operability of 66 per cent. There was one operative death. There were three three-year cures, or 13 per cent. of radical operations. Early exploration, with permission for immediate amputation, is safer treatment in a doubtful case than delay. No material benefit was obtained by Coley serum in the four cases in which it was employed. The average duration of life of the cases dying of recurrence was 11.5 months.

Benign Giant Cell Tumor—12 Cases.

9. *Etiology:* Trauma appeared as a causative agent in only three cases.

10. *Symptoms:* These tumors occur commonly in young adults, but are encountered at all ages. Swelling and pain are the characteristic symptoms. Spontaneous fracture occurred in only one case.

11. *X-rays:* The x-ray picture of a benign giant cell tumor is fairly distinctive. The tumors are of central origin, commonly near the epiphyseal ends of the long bones, but the spine, pelvis, jaw, etc., may be affected. The x-ray shows bone absorption in irregular spaces bounded by bony trabeculae. The cortex is thin and expanded. The tumor often crosses the epiphyseal line but in none of our cases perforated the joint cartilage.

12. *Diagnosis:* Bone cysts, osteitis fibrosa, and osteomyelitis must be excluded as well as metastatic tumors and sarcoma of the osteogenetic type.

13. *Pathology:* Benign giant cell tumors are composed of fairly typical fibroblasts and large numbers of endothelial foreign-body giant cells which dominate the microscopic picture. These giant cells are not significant as far as the tumor growth is concerned, and the cells of the fibroblastic tissue are regular in size, shape, and outline and show little evidence of malignancy. Osteoid tissue and cartilage may be observed but can frequently be explained by the presence of an epiphyseal line or a spontaneous fracture. New bone production is not characteristic of the tumors. We have no instance of metastasis.

14. *Treatment and Results:* Of the 12 traced cases of benign giant cell tumor, two have to be discarded as only six months have elapsed since operation. Of the remaining 10 cases, three had amputation performed, two had resection, while the other five cases had only incomplete removal of the tumor by incision and curettage. Of these cases, one died of pneumonia immediately after operation, and one is living but with evidence of tumor still present six months after operation. The remaining eight cases have passed the three year limit without evidence of disease.

15. *Recurrence:* No evidence of metastasis of giant cell tumor is found in this series, and where recurrence has been observed it is local and apparently due to incomplete removal of the tumor.

Angio-Sarcoma.

16. One case of this group occurred in the series,—a man of 60, with a tumor, apparently primary, in the ilium. No treatment other than exploratory operation was attempted, and the patient died within six months.

Myeloma.

17. Nine cases appeared in the records, but pathological proof of the diagnosis was obtained in only three. All three cases showed the microscopic picture of plasma cell myeloma, but in none did it appear to be systemic, and no Bence-Jones bodies were ever demonstrated. Two were instances of single foci of disease,—one of the ilium, the other of the humerus. The first case died of hemorrhage after an exploratory operation. The second case is alive and well three months after incision and curettage. The third case is of interest in that the

tumor appeared first in the orbit; two excisions were performed, with enucleation of the eye. Two years later, another tumor developed in the lower jaw. This was excised, recurred, and again excised, and the cavity treated by radium insertion. The case is now two years under observation without recurrence.

ABSTRACT OF OSTEOGENIC SARCOMA CASES.

CASE 2. *Hospital*—Massachusetts General, No. 205653. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—41 years. *Duration*—Six months; swelling of the knee. *Examination*—Enlargement of head of tibia. *X-ray*—"Extensive process upper end of tibia, probably giant-cell sarcoma." *Operation*—Amputation, mid-thigh. *Gross Examination*—Whitish growth, necrotic centre, filling upper part of shaft of tibia. *Microscopic Examination*—Ostogenic sarcoma. Fibro-cellular tumor; much necrosis, pleo-morphic cells and osteoid tissue (central type. *Result*—Died, three and a half years.

CASE 5. *Hospital*—Massachusetts General; No. 22879. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—58 years. *Duration*—One year; pain. *Examination*—Thickening about lower end of femur. *X-ray*—Cavity in external condyle, with increased growth of bone under periosteum. *Operation*—Exploratory operation for osteomyelitis. Three months later, amputation of mid-thigh. *Gross Examination*—New-growth, involving condyle and extending outward under periosteum. *Microscopic Examination*—Osteogenic sarcoma. Dense fibroblastic tissue; irregular pleomorphic cells with osteoid tissue (central type). *Result*—Two years; living, with recurrence in lung and abdomen.

CASE 7. *Hospital*—Massachusetts General; No. 220560. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—47 years. *Duration*—Five months; pain and limitation of motion. *Examination*—Mass in region of right hip. *X-ray*—Area of diminished density, greater trochanter. *Operation*—Exploration. Amputation refused. *Gross Examination*—Fragments of tissue with spongy bone. *Microscopic Examination*—Osteogenic sarcoma. Fibroblastic cellular tissue; cells pleomorphic; osteoid tissue. *Results*—Returned to hospital one month later; disease then considered inoperable.

CASE 8. *Hospital*—Massachusetts General; No. 224493. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—17 years. *Duration*—Three months; pain and swelling. *Examination*—Tumor, upper third of tibia. *X-ray*—Destructive process, upper end of tibia; worm-eaten appearance. *Operation*—Exploratory incision, followed by amputation of thigh. *Gross Examination*—Fibrous tumor, soft, reddish-gray, involving medulla and cortex. *Microscopic Examina-*

tion—Osteogenic sarcoma. Highly cellular stroma; pleomorphic cells with many mitoses; differentiated to cartilage and bone. *Result*—Died in one year; lung recurrence.

FIG. 1.

FIG. 2.

FIG. 1.—Case 9. Osteogenetic sarcoma of the lower end of the femur in a boy of ten. The tumor has dissected up the periosteum and infiltrated the medulla. Amputation. Death one year later of lung metastases. (See Fig. 2.)

FIG. 2.—Case 9. Osteogenetic sarcoma of periosteal origin of the lower end of the femur. (See Fig. 1.) The radiating lines of new formed bone in the periosteal tumor and the dissecting up of the periosteum are characteristic of this form of sarcoma.

CASE 9. *Hospital*—Massachusetts General; No. 237896. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—10 years. *Duration*—Five months; tumor. *Examination*—Fluctuating tumor, size of orange, lower end of femur; skin red; veins dilated. *X-ray*—Periosteal type of tumor with radiating lines of new formed bone, involving also medullary cavity. *Operation*—Amputation, mid-thigh. *Gross Examination*—Tumor lower end of femur, dissecting up periosteum; medullary cavity infiltrated. *Microscopic Examination*—Os-

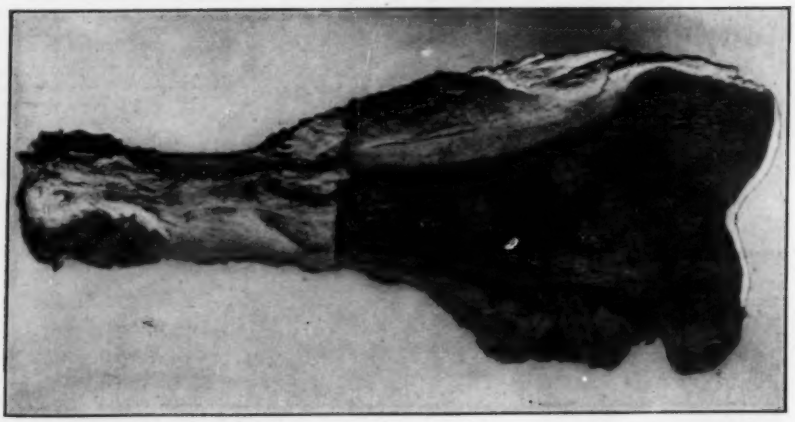

FIG. 3.—Case 26. Osteogenetic sarcoma of the lower end of the femur in a man 31 years of age, of three months' duration. The tumor originated under the periosteum but invades the medulla. Amputation. No evidence of disease 15 months later. (See Fig. 4.)

FIG. 4.—Case 26. Osteogenetic sarcoma of the lower end of the femur of periosteal type. (See Fig. 3.)

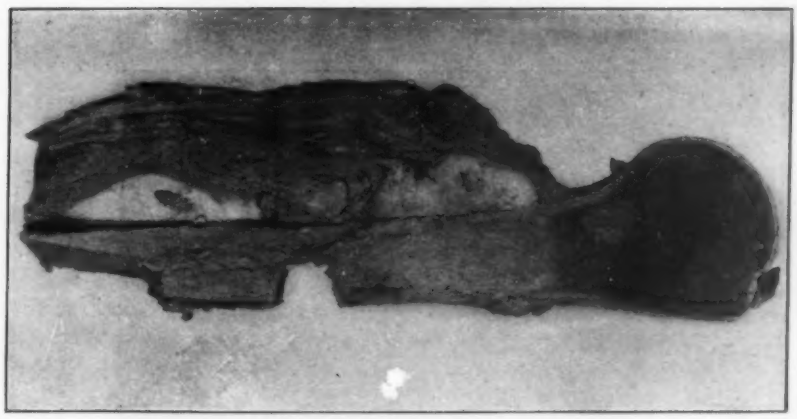

FIG. 5.—Case 23. Photograph of specimen. (See Fig. 6.) There is a large tumor under the periosteum, invading the soft parts and extending into the medulla. An isolated tumor nodule can be seen near the head of the bone.

FIG. 6.—Case 23. Osteogenetic sarcoma of humerus, destructive type, of six weeks' duration in a man of 32 years. The humerus has a worm-eaten appearance and there is very little new bone formation. Amputation. Death from recurrence in three months. (See Fig. 5.)

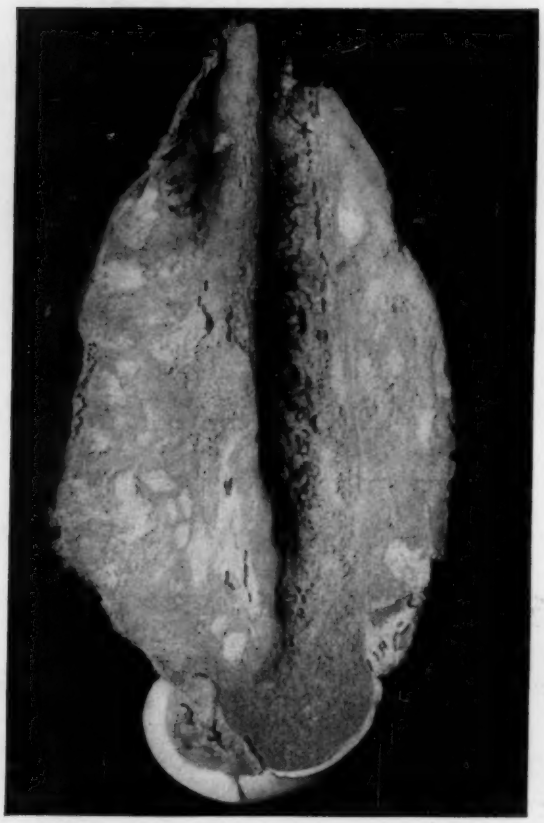

FIG. 7.—Case 12. Osteogenetic sarcoma of the lower end of the femur of one year's duration in a woman 34 years old. Periosteal type with much new bone formation (sclerosed type of Ewing) and little involvement of the marrow cavity. Amputation. Living without evidence of disease three years later.

teogenic sarcoma. Pleomorphic fibro-cellular tumor, new bone and cartilage production; many mitoses. *Result*—Death in one year; lung metastasis.

CASE 12. *Hospital*—Massachusetts General; No. 222422. *Diagnosis* Osteogenic sarcoma, sclerosing type—femur. *Sex*—Female. *Age*—34 years. *Duration*—One year; swelling and pain. Trauma six years before. *Examination*—Hard fusiform tumor, lower end of femur. *X-ray*—Tumor arising from periosteum, lower end of femur. Dense shadow with radiating lines of periosteal tumor. *Operation*—Exploration and immediate mid-thigh amputation. *Gross Examination*—Hard, bony tumor of cortex of shaft of femur with areas of soft

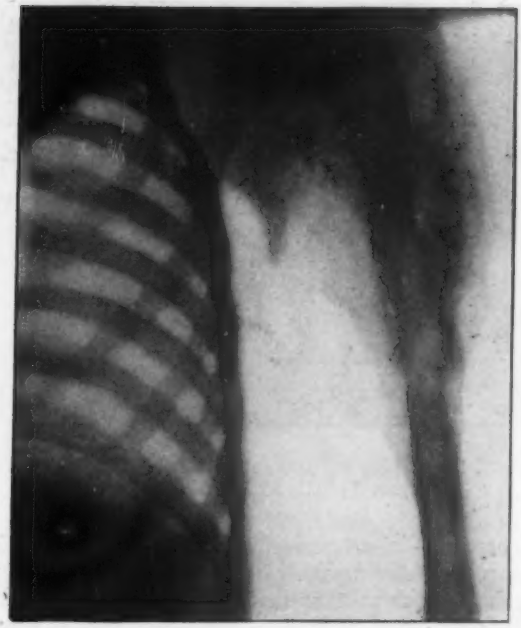

FIG. 8.—Case 55. Osteogenetic sarcoma of the periosteal type in a girl of 12 years. There is much bone destruction with a pathological fracture, and some bone formation, but the characteristic radiating lines of periosteal sarcoma are not seen. Amputation two weeks after exploratory incision. No recurrence ten months later. (See Fig. 9.)

tissue scattered through the bone. Medullary cavity not obliterated. *Microscopic Examination*—Osteogenic sarcoma. Cellular fibroblastic tissue with many areas of osteoid tissue, cartilage, and bone. Relatively few mitotic figures. *Result*—Well, three years.

CASE 22. *Hospital*—Massachusetts General; No 211086. *Diagnosis*—Osteogenic sarcoma—fibula. *Sex*—Male. *Age*—28 years. *Duration*—Eight months; pain and tumor. Trauma one month before onset. Two previous operations for supposed osteomyelitis, one month and four months after onset of symptoms. *Examination*—Fusiform swelling, lower end of fibula; foot swollen. *X-ray*—Central tumor lower end of fibula, destroying bone and extending through cortex to soft parts in one area (suggests benign giant cell tumor). *Operation*—Resection lower end of fibula. *Gross Examination*—Tumor occupies lower end of fibula, destroying shaft and infiltrating cortex and medulla; apparently encapsulated. *Microscopic Examination*—Osteogenic sarcoma. Chiefly small, round cellular fibroblastic tissue with new bone formation. *Result*—Died in one year; lung metastasis.

FIG. 9.—Case 55. Photograph of specimen. (See Fig. 8.) The pathological fracture, partially healed, is seen.

CASE 23. *Hospital*—Massachusetts General; No. 215298. *Diagnosis*—Osteogenic sarcoma—humerus. *Sex*—Male. *Age*—32 years. *Duration*—Five weeks; pain and rapidly growing tumor. Injury to arm immediately before onset. *Examination*—Large tumor mass upper end of shaft of humerus; red and fluctuating. *X-ray*—Worm eaten appearance of diffuse bone absorption, upper half of humerus; slight periosteal proliferation; suggests osteomyelitis or central sarcoma. *Operation*—Exploratory incision and immediate amputation at shoulder-joint. *Gross Examination*—Large tumor infiltrating upper end of humerus and adjacent soft parts. Considerable bone destruction and medullary cavity infiltrated. One nodule in head of humerus. *Microscopic Examination*—Osteogenic sarcoma. Large pleomorphic, fibroblastic type of cells: many mitoses; osteoid tissue, cartilage, and new bone. *Result*—Died. Symptoms not stated; few months after leaving hospital.

CASE 25. *Hospital*—Massachusetts General; No. 180922. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Female. *Age*—15 years. *Duration*—Three months. Pain; later swelling, immediately following trauma. *Examination*—Diffuse fusiform swelling upper end of tibia; slightly tender. *X-ray*—"Typical periosteal sarcoma." Not available for reëxamination. *Operation*—Amputation of mid-thigh. *Gross Examination*—Dense, whitish tumor, grating under knife, originating in head of tibia and extending outward from cortex. *Microscopic Examination*—Osteogenic sarcoma. Large fibroblastic type of cells, round and spindle in shape. Many mitoses, differentiating into osteoid tissue, cartilage, and bone. *Result*—Died six months later; local and lung recurrence.

FIG. 10.—Case 22. Osteogenetic sarcoma of central origin in the lower end of the fibula in a man 28 years old. Nine months' duration. Two previous operations for "osteomyelitis." Resection. Death one year later from lung metastasis. (See Fig. 11.)

CASE 26. *Hospital*—Massachusetts General; No. 234464. *Diagnosis*—osteogenic sarcoma—femur. *Sex*—Male. *Age*—31 years. *Duration*—Three months; pain and tumor. *Examination*—Fusiform tumor, lower end of left femur. *X-ray*—Extensive proliferative and destructive process; cortex destroyed, radiating lines of new bone extending outward. *Operation*—Amputation of femur. *Gross Examination*—Tumor originating under periosteum, lower end of femur, extending outward; medullary cavity infiltrated. *Microscopic Examination*—Osteogenic sarcoma. Large spindle shaped cells; differentiated to osteoid tissue, cartilage, and bone; few mitoses. *Result*—Well, fifteen months.

CASE 27. *Hospital*—Massachusetts General; No. 195458. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—20 years. *Duration*—Seven months; pain and tenderness *Examination*—Fusiform tumor of lower half of femur. *X-ray*—No data preserved. *Operation*—Amputation of thigh. *Gross Examination*—Spindle shaped growth involving lower end of femur, 8 cm. in diameter; cystic areas and bone. *Microscopic Examination*—Osteogenic sarcoma. Cellular, pleomorphic, fibroblast tissue; "tumor" giant cells; osteoid tissue and bone formation. *Result*—Died, with symptoms of lung recurrence, eighteen months.

CASE 28. *Hospital*—Massachusetts General; No. 195542. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Female. *Age*—24 years. *Duration*—Six months; tumor below knee. *Examination*—Hard, inelastic tumor, size of half an orange, over head of tibia; tender and veins dilated. *X-ray*—"Periosteal sarcoma." Not available for reexamination. *Operation*—Amputation mid-thigh. *Gross Examination*—Hard tumor, head of tibia, infiltrating bone. *Microscopic Examina-*

FIG. 11.—Case 22. Central osteogenetic sarcoma of the lower end of the fibula, in a man of 28 years. (See Fig. 10.) The picture closely resembles that of central giant cell tumor.

tion—Osteogenic sarcoma. Fibroblastic cellular tumor, differentiated to myxoma, osteoid tissue, and bone. Few mitoses. *Result*—Died five years and four months later, of pneumonia, during influenza epidemic, after brief illness. No evidence of recurrence.

CASE 30. *Hospital*—Massachusetts General; No. 185952. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—16 years. *Duration*—Unknown. *Examination*—Tumor size of orange in popliteal space; ulcerated. *X-ray*—Showed periosteal involvement of upper end of tibia. *Operation*—Amputation mid-thigh. *Gross Examination*—Tumor of upper part of leg, originating in tibia, infiltrating muscles. *Microscopic Examination*—Osteogenic sarcoma. Cellular, fibroblastic tissue; large round and spindle cells; differentiated to osteoid and myxomatous tissue and cartilage. Foreign-body giant cells. *Result*—Died one year later; lung metastases.

CASE 31. *Hospital*—Massachusetts General; No. 207366. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—38 years. *Duration*—Fifteen months, pain; tumor two months. *Examination*—Thick

FIG. 12.—Case 35. Giant cell tumor of two years' duration in a negro, 40 years of age. There is a very thin shell of bone left around the tumor. The joint cartilage is intact. Resection. No evidence of recurrence five and one-half years later. (See Fig. 13.)

FIG. 13.—Case 35. Photograph of specimen. (See Fig. 12.) The articular surface can be seen to the left, and a short section of the normal ulna to the right. The tumor itself is hæmorrhagic and friable.

ening about great trochanter; not tender; veins dilated. *X-ray*—Typical periosteal tumor infiltrating head and neck of femur, and half way down shaft. *Operation*—Exploratory incision and removal of specimen; considered inoperable. *Gross Examination*—Fragments of

tissue. *Microscopic Examination*—Osteogenic sarcoma. Pleomorphic type; fibroblastic tissue; differentiated to cartilage and bone. *Result*—Died three months later.

CASE 34. *Hospital*—Massachusetts General; No. 185610. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—26 years. *Duration*—Eighteen months, tumor; bloody sputum lately. *Examination*—Large tumor upper end of tibia; ulcerated. Previous exploratory operation. *X-ray*—"Sarcoma of tibia." Not available for reëxamination; metastases in lung. *Operation*—Amputation of thigh with dissection of groin. *Gross Examination*—Tumor upper end of tibia, reddish color. Joint not involved. *Microscopic Examination*—Osteogenic sarcoma. Pleomorphic, fibroblastic tumor; large, irregular cells; many mitoses; differentiated to cartilage, myxomatous tissue, and bone; much necrosis. *Treatment*—Coley serum. *Result*—Died seven months later; local and lung recurrence.

CASE 36. *Hospital*—Massachusetts General; No. 203722. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—20 years. *Duration*—Five months, following trauma; pain; later tumor. *Examination*—Tumor lower end of femur, soft, red, and tender. *X-ray:*—"Probable periosteal sarcoma;" not available for reëxamination. *Operation*—Amputation mid-thigh. *Gross Examination*—Tumor involving condyle of femur. *Microscopic Examination*—Osteogenic sarcoma. Fibrocellular tissue; oedema; differentiated to cartilage, myxomatous tissue, and bone; few tumor giant cells. *Results*—Lung metastases fourteen months later.

CASE 39. *Hospital*—Massachusetts General; No. 201213. *Diagnosis*—Osteogenic sarcoma—ribs. *Sex*—Female. *Age*—17 years. *Duration*—Four months, following trauma; tumor. *Examination*—Hard tumor 4 cm. in chest wall. *X-ray*—Not available for study. *Operation*—Resection fourth to ninth ribs with tumor. *Gross Examination*—Portion of ribs with large tumor mass arising from one rib. *Microscopic Examination*—Osteogenic sarcoma. Fibroblastic tissue with many blood spaces, cartilage, and bone. *Result*—Died in six months; lung involvement.

CASE 41. *Hospital*—Massachusetts General; No. 200860. *Diagnosis* Osteogenic sarcoma—tibia. *Sex*—Female. *Age*—16 years. *Duration*—Three months, pain in knee. *Examination*—Tumor of upper end of tibia, size of an orange. *X-ray*—Not available for study. *Operation*—Amputation mid-thigh three weeks after exploratory incision. *Gross Examination*—Opaque tumor arising in periosteum and infiltrating head of tibia. *Microscopic Examination*—Osteogenic sarcoma. Very cellular fibroblastic type, large and rounded cells; many mitoses; differentiated to osteoid tissue and bone; occasionally tumor giant cell. *Result*—Died one year later after second operation for local recurrence.

CASE 44. *Hospital*—Massachusetts General; No. 223558. *Diagnosis*—Osteogenic sarcoma—lower jaw. *Sex*—Male. *Age*—65 years. *Duration*—Two and a half months; pain; later tumor. *Examination*—

FIG. 14.—Case 3. Giant cell tumor of the upper end of the humerus of two years' duration in a girl of 13 years. The tumor extends through the epiphyseal cartilage. Curetted. No evidence of recurrence fifteen months later.

Tumor filling ramus of lower jaw; ulcerated. *X-ray*—Not available for reëxamination. *Operation*—Resection one-half of lower jaw, following incision and curettage in another hospital. *Gross Examination*—Tumor mass involving jaw and infiltrating bone, 4 x 6 cm. *Microscopic Examination*—Osteogenic sarcoma. Fibrous type; fibroblastic tissue; differentiated to osteoid tissue and bone. *Result*—Well, three years.

CASE 45. *Hospital*—Massachusetts General; No. 175122. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—17 years. *Duration*—Three months; pain; later tumor. *Examination*—Fusiform tumor upper end of tibia. *X-ray*—No record. *Operation*—Exploratory incision and immediate amputation of mid-thigh. *Gross Examination*—Tumor involving head of tibia, extending to soft parts; cortex and medulla infiltrated. *Microscopic Examination*—Osteogenic sarcoma. Fibroblastic tissue; large and rounded cells; differentiated to osteoid tissue, cartilage, and bone. *Result*—Metastasis in spine, ten months later.

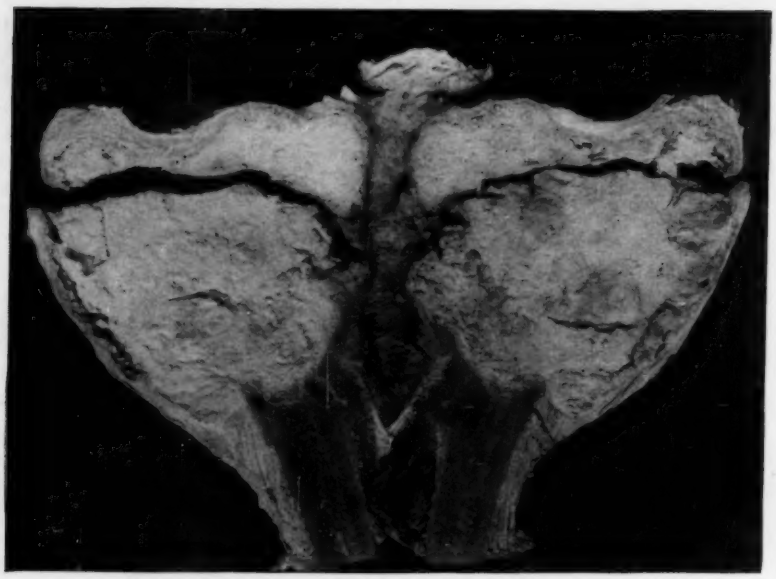

FIG. 15.—Case 21. Large giant cell tumor, upper end of tibia, in a woman 44 years old. The bone is reduced to a thin shell and there is a pathological fracture, but the joint is not invaded. Amputation. No evidence of recurrence three years later.

CASE 47. *Hospital*—Massachusetts General; No. 204119. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—53 years. *Duration*—Five months; tumor. *Examination*—Tumor, posterior aspect of tibia, hard, not tender; size of an orange. *X-ray*—Bony tumor involving posterior aspect of tibia, suggests periosteal sarcoma. Not available for reëxamination. *Operation*—Exploratory incision with removal of specimen. Mid-thigh amputation one week later. *Gross Examination*—Grayish tumor, soft consistency, involving upper end of tibia. *Microscopic Examination*—Osteogenic sarcoma. Fibroblastic tissue; differentiated to cartilage and bone. Specimen also shows areas of fibrous stroma with hæmorrhage, and foreign-body giant cells (benign giant cell tumor). *Result*—Died in one year; lung recurrence.

CASE 48. *Hospital*—Massachusetts General; No. 186737. *Diagnosis*—Osteogenic sarcoma—spine. *Sex*—Male. *Age*—42 years. *Duration*—Six months; pain; tumor lately. *Examination*—Large tumor right iliac fossa, extending over sacrum and lower lumbar vertebrae. *X-ray*—Indefinite mass right iliac fossa; not available for reexamination. *Operation*—Exploratory incision; large tumor mass connected with transverse processes of lumbar vertebrae, and extending into iliac fossa. *Gross Examination*—Gray, firm cartilaginous fragments of tumor tissue. *Microscopic Examination*—Osteogenic

sarcoma. Chiefly cartilage and new bone, and areas of fibroblastic cellular tissue. *Result*—Died one year later; general sarcomatosis.

CASE 49. *Hospital*—Massachusetts General; No. 186737. *Diagnosis*—Osteogenic sarcoma—ischium. *Sex*—Male. *Age*—42 years. *Duration*—Six months; pain and tumor. *Examination*—Smooth, rounded tumor, pubis to ischium. *X-ray*—Loss of bone substance right side of pelvis (not available for study). *Operation*—Exploratory incision; firm tumor containing cystic areas. *Gross Examination*—Fragments of firm grayish-white tumor tissue. *Microscopic Examination*—Osteogenic sarcoma. Large fibroblastic cells with vesicular nuclei; pleomorphic; many mitoses; few tumor giant cells (differentiation to osteoid tissue and bone). *Treatment*—Coley toxines administered. *Result*—Died four months later.

CASE 54. *Hospital*—Collis P. Huntington Memorial—18-985. *Diagnosis*—Osteogenic sarcoma—tibia. *Sex*—Male. *Age*—21 years. *Duration*—Nine months; pain; tumor later. Three exploratory operations in six months for supposed osteomyelitis, followed by amputation at mid-thigh three months before entrance to Huntington Hospital. *Examination*—Mid-thigh stump, bone protruding. No evidence of local recurrence. *X-ray*—Of chest shows lung recurrence. *Gross Pathology*—No report. *Microscopic Examination*—Osteogenic sarcoma. From specimen removed at amputation shows pleomorphic, fibroblastic, cellular tissue; alveolar arrangement; large vesicular nuclei; mitoses abundant; tumor giant cells; small areas of hæmorrhage; differentiated to osteoid tissue. *Result*—Died one month later.

CASE 55. *Hospital*—Collis P. Huntington Memorial—20-322. *Diagnosis*—Osteogenic sarcoma—humerus. *Sex*—Female. *Age*—12 years. *Duration*—Doubtful; pathologic fracture ten days before entrance. *Examination*—Large, lobulated tumor upper half of humerus; red, tender, and fluctuant. *X-ray*—Much bone destruction and some new bone formation upper half of humerus, with pathological fracture; suggests osteomyelitis. *Operation*—Exploratory incision; specimen showed sarcoma; two weeks later, amputation at shoulder-joint. *Gross Examination*—Large tumor occupying upper end of humerus and extending into soft parts; soft and gray, with areas of necrosis with cortex destroyed and fracture of upper third. *Microscopic Examination*—Osteogenic sarcoma. Large-celled fibroblastic tissue; alveolar arrangement; infiltrating soft parts and bone; differentiated to osteoid tissue, cartilage, and bone. Infiltrating and destructive type of tumor. *Result*—Well, one year; no evidence of local or internal recurrence.

CASE 56. *Hospital*—Collis P. Huntington Memorial—20-813. *Diagnosis*—Osteogenic sarcoma—upper jaw. *Sex*—Male. *Age*—12 years. *Duration*—Eleven months, tumor; later, exophthalmos; loss of vision. *Examination*—Enormous tumor of upper jaw, displacing eye and

palate and extending into zygomatic fossa. *X-ray*—Large tumor mass in region of antrum. *Operation*—Resection of upper jaw and tumor. *Gross Examination*—Firm, grayish tumor tissue, showing areas of degeneration and oedema, apparently springing from region of ethmoid cells and involving and destroying upper jaw. *Microscopic Examination*—Osteogenic sarcoma. Fibroblastic cellular tissue, relatively uniform in character; many lymph spaces and blood channels; differentiated to myxomatous and osteoid tissue. *Result*—Died twenty-four hours following operation, shock and hemorrhage.

CASE 57. *Hospital*—Collis P. Huntington Memorial—16-151; Massachusetts General Hospital—No. 207195. *Diagnosis*—Osteogenic sarcoma—femur. *Sex*—Male. *Age*—14 years. *Duration*—Two months; pain. *Examination*—Tumor lower end of femur; enlarged glands in groin and abdomen. *X-ray*—Periosteal new growth lower end of femur; new bone formation and medulla invaded. *Operation*—Massachusetts General Hospital. Amputation of thigh. *Gross Examination*—Tumor originating under periosteum, lower end of femur; infiltrating medullary cavity. *Microscopic Examination*—Osteogenic sarcoma. Pleomorphic fibroblastic cellular tissue; alveolar arrangement; differentiation to osteoid tissue, cartilage, and bone. Foreign-body giant cells. *Result*—Died two and a half months later, with extension to abdominal cavity.

ABSTRACT OF BENIGN GIANT-CELL TUMOR CASES.

CASE 1. *Hospital*—Massachusetts General; No. 206129. *Diagnosis* Benign giant-cell tumor—phalanx. *Sex*—Female. *Age*— 58 years. *Duration*—One year; tumor and pain. Incision and curetting six months before entrance. *X-ray*—Central expanding tumor, thin cortex; bone destruction. *Operation*—Amputation of finger. *Gross Examination*—Soft, red tumor tissue within thin bone shell of cortex of phalanx. *Microscopic Examination*—Benign giant-cell tumor. Many large, multinucleated giant-cells, fibrocellular stroma; areas of hæmorrhage; no new bone production. *Result*—Well, five years.

CASE 3. *Hospital*—Massachusetts General; No. 224111. *Diagnosis* —Benign giant-cell tumor—head of humerus. *Sex*—Female. *Age*—13 years. *Duration*—One year; tumor of shoulder; pain recently. *Examination*—Hard, smooth tumor, size of an egg, greater tuberosity. *X-ray*—Central tumor, crossing epiphyseal line, thin cortex; bone destruction. *Operation*—Incision and curettage. *Gross Examination* —Red, friable fragments of tumor tissue. *Microscopic Examination*— Benign giant-cell tumor. Numerous small giant-cells, fibrous type stroma; new bone and cartilage (attributed to line of epiphysis). *Result*—Well, fifteen months.

CASE 4. *Hospital*—Massachusetts General; No. 238762. *Diagnosis* —Benign giant-cell tumor—great trochanter. *Sex*—Female. *Age*—

13 years. *Duration*—Eight months, pain and lameness. *Examination*—Thickening over trochanter; hip motion slightly restricted. *X-ray*—Central tumor, great trochanter, extending through epiphysis; thin cortex; bone destruction. *Operation*—Incision and curettage. *Gross Examination*—Red, friable fragments of tumor tissue. *Microscopic Examination*—Benign giant-cell tumor. Many large giant-cells, cellular type fibrous stroma; new bone and cartilage (attributed to line of epiphysis). *Result*—Well, six months.

CASE 6. *Hospital*—Massachusetts General; No. 183172. *Diagnosis*—Benign giant-cell tumor—spine. *Sex*—Male. *Age*—16 years. *Duration*—Trauma three months before symptoms; three months' pain and tenderness, and thickening over lumbar spine. *X-ray*—Small tumor arising from lateral surface spinous process third lumbar vertebra. *Operation*—Excision (partial). *Gross Examination*—Fragments of tissue. *Microscopic Examination*—Benign giant-cell tumor. Many small giant-cells, stroma fibrous type; no hæmorrhagic areas; no new bone. Local recurrence in wound immediate. Received Coley toxin treatment by injection direct into tumor, for seven months (sixty-two injections). Tumor sloughed out and wound healed. Two years later tumor appeared in scar; excised and found to be a cyst; inflammatory tissue; no tumor tissue found. *Result*—Well eight years after first operation.

CASE 18. *Hospital*—Massachusetts General; No. 208764. *Diagnosis*—Benign giant-cell tumor—lower jaw. *Sex*—Female. *Age*—8 years. *Duration*—Three months' tumor. *Examination*—Smooth, hard tumor right side of lower jaw. *X-ray*—Destroyed; not available. *Operation*—Incision and curettage. *Gross Examination*—Fragments of tissue from central tumor of lower jaw. *Microscopic Examination*—Benign giant-cell tumor. Many giant-cells, stroma very fibrous; areas of hæmorrhage; some bone trabeculae found; no evidence of new bone formation. *Result*—Well; no recurrence, four and a half years.

CASE 19. *Hospital*—Massachusetts General; No. 214282. *Diagnosis*—Benign giant-cell tumor—femur. *Sex*—Female. *Age*—9 years. *Duration*—Two days. Spontaneous fracture of femur. *X-ray*—Central tumor of lower end of shaft of femur with bone destruction and fracture. *Operation*.—Incision, curettage, reduction of fracture. *Gross Examination*—Fragments of tissue. *Microscopic Examination*—Benign giant-cell tumor. Few giant-cells, cellular fibrous stroma; hæmorrhagic areas; no new bone formation. *Result*—Well four years later; good union.

CASE 21. *Hospital*—Massachusetts General; No. 210501. *Diagnosis*—Benign giant-cell tumor—tibia. *Sex*—Female. *Age*—44 years. *Duration*—Three and a half years. *Examination*—Tumor size of a grapefruit, head of tibia. *X-ray*—Central tumor expanding cortex; bone destruction; spontaneous fracture. *Operation*—Amputation of

thigh. *Gross Examination*—Central tumor of head of tibia, gray, firm; thin shell of cortex broken in places. *Microscopic Examination*—Benign giant-cell tumor. Many large giant-cells; fibrous stroma; no marked hæmorrhage; no new bone formation. *Result*—Well, four and a half years.

Case 35. *Hospital*—Massachusetts General; No. 201079. *Diagnosis*—Benign giant-cell tumor—ulna. *Sex*—Male (colored). *Age*—40 years. *Duration*—Fifteen months. *Examination*—Tumor of elbow, rapid recent growth, size of fist, upper end of ulna; motion slightly restricted. *X-ray*—Central tumor, expanding upper end of ulna; thin cortical shell; no extension into joint. *Operation*—Resection of upper third of ulna. *Gross Examination*—Central friable tumor, many hæmorrhagic areas, distinct thin bone-shell; articular cartilage intact. *Microscopic Examination*—Benign giant-cell tumor. Large number of giant-cells; cellular stroma; much hæmorrhage; no new bone elements. *Result*—Well, six years.

Case 37. *Hospital*—Massachusetts General; No. 175702. *Diagnosis*—Benign giant-cell tumor—tibia. *Sex*—Male. *Age*—27 years. *Duration*—One year pain; later swelling over head of tibia. *X-ray*—"Dense shadow, head of tibia." Not preserved for reëxamination. *Operation*—Incision and curettage of giant-cell tumor in March; repeated in April; amputation, mid-thigh, done in May. *Gross Examination*—No record. *Microscopic Examination*—Benign giant-cell tumor. Few giant-cells; cellular stroma of fibroblasts; several areas of hæmorrhage, some new bone formation attributed to healing of fracture. *Result*—Well, ten years.

Case 38. *Hospital*—Massachusetts General; No. 178456. *Diagnosis*—Benign giant-cell tumor—fibula. *Sex*—Female. *Age*—33 years. *Duration*—One and a half years; trauma immediately before tumor; lameness. *X-ray*—No record. *Operation*—Resection, upper end of fibula. *Gross Examination*—Central lobulated new growth; thin, bony walls and cysts of thin, bloody fluid. *Microscopic Examination*—Benign giant-cell tumor. Many giant-cells; cellular stroma; hæmorrhagic areas; no bone formation. *Result*—Well, ten years.

Case 51. *Hospital*—Collis P. Huntington Memorial—15-95. *Diagnosis*—Benign giant-cell tumor—upper jaw. *Sex*—Male. *Age*—28 months. *Duration*—Six months. *Examination*—Tumor of upper jaw filling antrum, displacing eye and depressing palate. *X-ray*—No record. *Operation*—resection; colonic ether anæthesia, transfusion. *Gross Examination*—Upper jaw containing soft red tumor tissue. *Microscopic Examination*—Benign giant cell tumor. Numerous giant-cells; rich fibrocellular stroma with considerable variation in size and shape of cells; small areas of hæmorrhage; no evidence of new bone. *Result*—Death in twenty-four hours; shock; lobar pneumonia. Autopsy No. 3492.

CASE 58. *Hospital*—Collis P. Huntington Memorial——20-1222. *Diagnosis*—Benign giant-cell tumor—radius. *Sex*—Female. *Age*—68 years. *Duration*—Three months; pain. *Examination*—Tumor lower end of radius. *X-ray*—Central tumor, destroying bone. *Operation*—Incision and curettage; immediate recurrence and rapid growth. Operation, four months later, incision, curettage, cavity packed with radium emanation in steel needles. Second radium treatment (external) two months later. *Gross Examination*—Fragments of red, friable tissue. *Microscopic Examination*—Benign giant-cell tumor. Many giant-cells; rich cellular stroma; much hæmorrhage; no bone formation. *Result*—Eleven months from first operation wound healed; no evidence of recurrence.

ABSTRACT OF ANGIO-ENDOTHELIOMA CASE.

CASE 17. *Hospital*—Massachusetts General; No. 194019. *Diagnosis*—Angiosarcoma—ilium. *Sex*—Female. *Age*—60 years *Duration*—Seven months; pain. *Examination*—Mass 3 x 8 cm. right iliac fossa, attached to ilium; not tender. *X-ray*—Shows pathological process, involving sacroiliac region. *Operation*—Exploratory incision; soft tumor with thin bony capsule; curettage. *Gross Examination*—Fragments of soft, reddish tissue. *Microscopic Examination*—Angiosarcoma. Tumor tissue composed largely of blood spaces in a stroma of irregular pleomorphic fibroblastic tissue; the blood spaces lined with large, irregular endothelial cells; areas of osteoid tissue, question whether new-formed or not. *Result*—Died in six months.

ABSTRACT OF MYELOMA CASES.

CASE 11. Massachusetts General; No. 185159. Abstracted in text.

CASE 20. Massachusetts General. No. 137240. Abstracted in text.

CASE 52. Massachusetts General; No. 221685. Collis P. Huntington Memorial; No. 15-382. Abstracted in text.

DISCUSSION OF PAPER BY DRS. GREENOUGH, SIMMONS, AND HARMER.

DR. E. A. CODMAN, Boston: I thank you very much for the opportunity to discuss this paper. I have tried to study the subject of bone sarcoma for only a year, and I do not have any claim to be an authority on it. I have not cured cases, and have nothing to speak about in that way. I cannot even authoritatively discuss the paper, but I can tell you in a few words the reason that I think it is an important paper, and a little about the Registry of Bone Sarcoma.

The paper has taught me more on some points than I have been able to get out of the Registry. In the Registry we have endeavored to get in communication with as many surgeons in this country as possible, and ask them to send us a brief account with x-ray and pathological specimen, of any living cases of bone sarcoma that they have or suppose they have. We have laid an accent on "suppose they have," because, naturally, many men have made the same mistake that we did in the case related by Dr. Greenough, in suppos-

ing it was bone sarcoma when it was really cancer. I hope the members of this Association will help us in the same way, and register any cases that they have with us, that is, with Dr. Bloodgood, Dr. Ewing, and myself. We are endeavoring to register these cases so as to get the specimens and put them together in some place where they will be available for the study of anyone who is authorized or is interested to study them. We have collected a good many cases, but have not found as many cases of true sarcoma as have been reported in this paper. This series of Dr. Groonough and Dr. Simmons gives us hope in a case of true osteogenic sarcoma, that amputation may cure it. We have been able to find but few others in the whole country. There is one objection to accepting Dr. Greenough's and Dr. Simmons's cases. They have not yet registered them. Dr. Bloodgood, Dr. Ewing, and I should go over them and have a chance to express an opinion as to whether they are clearly cases of sarcoma. We may have a difference of opinion, but, at any rate, the data will be in the Registry for the use of future students of the subject.

DR. WALTER G. STERN, Cleveland: We, as practical surgeons, must be greatly indebted to the essayists and to Dr. Codman and his fellow workers, who have so boldly launched a new method of studying bone sarcoma. When one looks over the most recent literature of the subject, one is surprised to learn that there are so few authenticated cases alive after three or four years. Then, too, the various classifications are misleading. The speaker adheres to Ewing's classification, which seems the best. Taking Bloodgood's, which divides the growths into more benign central bone lesions and periosteal lesions, one would think that the former group, the central bone tumors, ought to show the better prognosis, but in reading over the literature one finds that the prognosis in that class of cases is almost as bad as in the second group, that of periosteal sarcoma. In periosteal sarcoma Bloodgood had only two cases alive after three years, and in the central bone lesions, he had seven cases alive at the end of five years, and the average duration of life in all cases was a little over one year.

Then, too, central sarcomata can change their characteristics and take on the attributes of the more malignant type as illustrated by a case recently under my care. A man, injured in an accident some eight years ago, soon afterward developed a growth in the upper end of the tibia that the older x-rays would lead one to believe to be a non-malignant central tumor. After eight years, the tumor suddenly grew rapidly larger, broke through the bone shell, and invaded the periosteum and cartilages. When I first saw him there were no metastases, and the leg was amputated above the middle of the thigh, after an exploratory incision proved the tumor to be a malignant one; but within eight weeks afterwards the man developed metastases, showing that what one believed, after careful study, to be a central tumor of non-malignant type, may be malignant and metastasize after operative interference. It might be well to raise the question whether such exploratory operation is justifiable, because, when one looks over the literature, one finds that they are followed in large number of cases by metastases or recurrences. Bloodgood advises that it be done with actual cautery or followed by cauterization with carbolic acid.

The work of Dr. Codman should be given our appreciation and thanks. Personally, he has helped me wonderfully to understand my cases and to take added interest in this work.

DR. T. W. HARMER, Boston: The analysis of this little series of bone sarcoma developed two surprises. It is interesting that there are three cases of the osteogenic type in this series which have gone beyond the usual three year period. It is also interesting that despite the fact that an exploratory incision was made in several of these cases, curiously enough it did not seem to jeopardize the prognosis.

DR. PACKARD, Denver: I was anxious to show some plates of a case of supposed osteosarcoma inasmuch as the case had been discussed by Dr. Cod-

man and also by Dr. Coley of New York recently. This boy was injured in September, 1919. The picture was taken afterwards, and there was no fracture or pathology of any kind. In January, 1920, x-ray showed some pathology and Dr. Codman has seen the photographs, but not the films. The photographs were rather unsatisfactory. The case clinically presented a large swelling, fusiform, on the upper portion of the femur, and the x-ray showed disease of the acetabulum, neck, head, and upper portion of the femur. About four months from the time of injury, pathologic fracture took place. He was treated, thinking it might be some inflammatory condition, with fixation and extension, with no relief. He was then started with the Coley's fluid, given under the direction of Dr. Coley, and improvement began in about two months from the time we began the injection of the Coley fluid. The improvement continued for about six months. The swelling went down, the pain disappeared, and he was practically well, with the exception of an ununited fracture. He has remained well for nearly two years, and the fracture united. We have not had any microscopic examination, but clinically it seems a typical case of osteosarcoma.

Current Orthopaedic Literature

THE OPERATIVE LENGTHENING OF THE FEMUR. Vittorio Putti. *Journal A. M. A.*, Sept. 17, 1921, p. 934.

Cases in which operative lengthening of the femur is indicated form a very limited series where the amount of shortening is greater that two inches and the disability is of old standing. Among these cases are old war fractures and others in which the shortening is due to a congenital or acquired cause, such as an acute epiphysitis of the head of the femur, where the process of normal growth has been seriously interfered with.

Among the problems of the procedure is the amount of traction the soft parts, muscles, nerves, and vessels can stand and the means actually to be employed. It has been proved that the soft parts can stand the strain of stretching and lengthening wihout detriment. Of the means to be employed, direct skeletal traction must be employed; it must be constant, measurable, and have a counter point in bone itself. The instrument devised by Putti goes by the name of an osteoton and consists of two large metal pins to be fixed just below the trochanter major and into the condyles. These stout pins can be inserted into the bone without previous drilling and are connected by a telescoping tube in which is a strong spring controlled by a screw. In addition, it can be used as a dynamometer and a measurer of length. The bone itself is cut by a motor-saw, at or away from the site of the old callus, by a Z-shaped incision like that used for tendon lengthening. The after-treatment is very simple and knee and hip may both be flexed on a pillow. The apparatus is left on for a month and replaced by a plaster. Consolidation is usually delayed.

Ten cases have been operated upon and integral lengthening of three-fourths of an inch obtained. In one case, the femur was lengthened beyond the normal proportions. No trophic disturbances have been noticed, though in one case the patient had pain along the course of the sciatic and femoral nerves.—*W. A. Cochrane, Boston, Mass.*

TREATMENT OF UNUNITED FRACTURES OF THE NECK OF THE FEMUR BY BONE TRANSPLANTS. Charles Davison, *Journal A. M. A.*, Sept. 17, 1921, p. 916.

Autoplastic transplantation of bone combined with external immobilization is the line of treatment for the repair of nonunion after fracture.

The author advises the use of a segment of fibula for the repair of ununited fractures of the neck of the femur. It combines an ideal size and shape, strength, elasticity, and lightness, and after removal of periosteum the irregular cortical bone with its osteoblasts lying free makes a graft rich in

bone forming potentialities. The site of fracture is exposed by the anterior route and the bone ends cleared of fibrous tissue as far as possible. An incision is then made directly over the trochanter major and both fragments drilled for the reception of the graft, which is inserted with the limb in abduction; the route is controlled through the original exposure. The hole that is drilled must be of smaller bore than the diameter of the graft.

Immobilization is obtained by a double plaster spica extending well up into the axillae and the limb is splinted in full abduction and external rotation. The abduction causes the muscle pull to approximate the fragments and the external rotation relaxes the muscles inserted into the trochanter major.

The writer then goes on to speak of the principles of bone growth that underlie the procedure with the stimulation to osteogenesis and callus formation between the fragments. The operation does not restore length nor motion that depend upon a femoral neck of normal proportions.

The operation is not indicated in old people on account of shock and the deleterious effects of prolonged immobilization.—*W. A. Cochrane, Boston, Mass.*

End-Results of Reconstruction Operation for Ununited Fracture of Neck of Femur. Armitage Whitman. *Jour. A. M. A.*, Sept. 17, 1921, p. 913.

The proportion of cases of fracture of the neck of the femur that fail to unite is still large and probably lies between the 15% of Campbell's statistics and the 100% of Delbet. In addition to its frequency, the disability resulting from pain and the possession of an unstable hip, incapable of weight-bearing, invests these cases with a special interest. The procedures employed hitherto in these cases have not had brilliant results and leave the patient very often after months of treatment still with nonunion. The author passes in survey the methods of simple nailing by an ordinary steel pin, the use of tibial graft (Albee) or a fibular graft (Campbell-Delbet), and describes the development of operative scope and approach. They depend for success on ultimate bony union and this is an assumption not often borne out by results. In the large class of cases with destruction of the neck of the femur, union obtained by these pegging operations is gained at the expense of function, for when the hip is abducted the impingement of the top of the trochanter major on the ilium acts as a bony block.

Henderson, of the Mayo Clinic, shows 38% of good results in 26 cases, and Brackett found only one good result out of 24 cases.

The Whitman reconstructive operation is therefore applicable to cases in which the neck is absorbed and where bony union does not solve the functional disability. Neither does it depend upon the patient's inherent powers of osteogenesis.

The reconstruction operation removes the head of the bone. The trochanter major is chiselled off in a line continuous with the remaining portion of the neck. The surviving part of the neck is thrust into the acetabulum; the one bared by the removal of the trochanter provides a new neck. The trochanter is displaced downwards upon the shaft and attached to its denuded cortex by pegging or wiring. The muscles act so as to hold the end

of the femur within the acetabulum and resume their function as abductors and rotators. The limb is splinted for six weeks in a plaster spica.

Ten cases are reported and in all pain has been relieved and a stable weight-bearing hip obtained.—*W. A. Cochrane, Boston, Mass.*

DELAYED UNION AND NONUNION OF THE RADIUS AND ULNA. H. W. Meyerding. *Minnesota Medicine*, April, 1921.

Reconstruction surgery with restoration of function in delayed union and nonunion of the radius and ulna is made more difficult where the surgeon is confronted by the problems of deformity, infection, comminution, loss of bone substance, muscle degeneration, stiffness in neighboring joints, bone atrophy, impaired blood supply, and general constitutional disease. Another factor must be added to the causes of impaired union, that in which the process of ossification ceases from causes unknown before union is complete.

Imperfect reduction, inadequate fixation, and too early use were the chief predisposing factors in delayed union and nonunion of the fifty-nine cases reported.

Fixation must be carried beyond the elbow and beyond the wrist. It is highly important to make roentgenographic examination of all fractures before and after operation and at regular intervals while the patient is under observation. There is no fixed time for immobilization of the fracture, which time is based on the roentgenographic and clinical findings. If nonunion persists there is a resulting pseudo-arthrosis with fibrous union.

The cases considered as nonunion are those in which the fractures have failed to become firm within six months, and if less time has elapsed, delayed union is diagnosed. If syphilis is a possible factor, the opinion of a syphilologist is obtained, even though the Wassermann is negative.

The contraindications to operation must be considered. Infection must be adequately dealt with, sequestra and Lane plates removed, manipulation carried out, neighboring joints loosened up, the blood supply improved, bone atrophy overcome, and the general condition of the patient built up.

The massive graft, held by beef bone screws, and external fixation of plaster of Paris cast is the operation of choice. The graft is obtained from the tibia and is preferably larger in cross section than the excised half of the bone operated, so that new bone forms a bridge before the graft is weakened and when the danger of fracture is past. When the roentgenogram shows that strong, osseous tissue has formed, careful increase in use of the limb may be carried out. Light massage and careful exercise on removal of splints aid in improving circulation and loosening up stiffened parts. The splints may be removed during the day and applied at night in order to prevent injury during sleep.

Nonunion in the Radius and Ulna.
(Mayo Clinic, May, 1913, to June, 1920.)

Patients (54 males, 5 females)	59
Patients operated on for nonunion before examination at the Clinic (one had had seven operations), (54.4 per cent.)	32
Average age (oldest patient 78, youngest patient 8) years	33
Average time since fracture, months	15
Longest time since fracture, years	19

Site of Delayed Nonunion.

Radius and ulna (right 28, left 19)	47
Radius (right 5, left 3)	8
Ulna (right 1, left 3)	4

Operations.

Lane plate	6
Bone graft	31
Removal of Lane plate (three plates applied at Clinic)	8
Drainage for infection	10
Sequestrectomy, manipulation and so forth	4

Bone-graft Operations.

Patients (29 males, 2 females)		31
Average duration of nonunion (months)		22.2
Nonunion in radius and ulna (right 7, left 3)		10
Good union	4	
Improvement (ulna only united)	2	
Failure	1	
Information not obtained	3	
Nonunion in radius (right 10, left 8)		18
Good union	13	
Improvement	1	
Failure	1	
Information not obtained	3	
Nonunion in ulna (right 1, left 2)		3
Good union	1	
Information not obtained	1	

Results of Operations.

Patients from whom information has been received		34
Good union	25	
Failures	7	
Improvement	2	
Patients whose operations are too recent to include in results		7
Patients from whom information could not be obtained		18

—S. Brock, Rochester, Minn.

Downward Dislocation of the Patella. H. Rutherford. *British Journal of Surgery*, April, 1921.

The author has previously reported a case of dislocation downward of the patella. In this paper two other similar cases are reported; one in a man 42 years, and one in a boy 7 years of age. Each received a blow on the patella with the knee partially flexed, which was followed by immediate disability, pain, and swelling.

In the adult it was noted that the patella formed an unusual prominence between the femur and the tibia. The x-ray showed that the upper surface

of the patella was caught between the articular surfaces of the femur and the tibia, and the bone rotated so that the anterior surface pointed upwards; also that part of the superior edge of the patella had been torn away and remained with the quadriceps tendon.

This tends to confirm the view that upward and downward dislocation can only occur when associated with other lesions, particularly rupture of the quadriceps tendon or the patella ligament.

Reduction was accomplished by open operation. The final result in each case was satisfactory.—*J. I. Mitchell, Rochester, Minn.*

CASE OF PARAPLEGIA IN WHICH THE SECOND CERVICAL VERTEBRA WAS REMOVED: WITH A NOTE OF THE PATIENT'S CONDITION SEVENTEEN YEARS LATER. J. Hogarth Pringle. *British Journal of Surgery*, April, 1921.

Case of a boy, age 14, in Royal Infirmary, May, 1903. Complete paraplegia, except not absolute in left leg. Previous history of enlarged glands of neck, age 12; pains in head; weakness of left side two months before, attributed to a fall. Examination on entrance showed severe pain and tenderness in neck, with complete paraplegia except slight movements possible in left leg. Normal knee-jerks, ankle clonus, negative Babinski, retention of urine, and a fluctuating, tender swelling over whole cervical spine. Operated and the pus drained off and wound packed. Laminae of first three cervical vertebrae were found bared by the pus and the second vertebra was entirely necrosed. Next day the paraplegia had almost disappeared. One week later bladder and rectal symptoms ceased. Month later, abscesses formed on each side of neck and were opened, drained, and a part of first, all of second, except odontoid process, and upper part of third cervical vertebrae were removed, left vertebral artery cut but right was left intact. Three months elapsed and patient was discharged apparently recovered.

Seventeen years later patient again presented himself with almost same symptoms, except left lower leg was worse and also numbness in extremities in addition. Had worked as a riveter up to this time. Examination showed exaggerated knee-jerks, negative Babinski, no disturbance of sensation, clonus, neck shortened but no angular deformity. However, neck could not be rotated. Weak grip in both hands. X-ray showed absence of two cervical vertebrae.

Two months' extension to spine increased grip of hands to 80%. Five months later patient was seen and condition was better than original. No disturbances of sensation, but poor stereognostic sense. Original diagnosis of Pott's, but changed to subacute osteo-myelitis.

Today there is no deformity outside of shortening of neck.

Author states the most interesting point was how spine was shortened and cord accommodated.—*E. Ashbury, Rochester, Minnesota.*

EFFECT OF POSTURE ON THE HEALTH OF THE CHILD. Frank D. Dickson. *Jour. A. M. A.*, Sept. 3, 1921, p. 760.

This article describes correct posture and emphasizes its effect upon physical and mental development. He quotes Goldthwait, Brown and Talbot, D. P.

Willard, and others, and gives his experience with 48 cases observed long enough to allow some conclusions to be drawn as to symptoms and results. There are five illustrations, one showing a back brace which he uses. His conclusions are as follows:

1. Poor bodily mechanics may often explain why a child is not enjoying the health and development it should, and may even explain acute conditions which may be affecting it. Therefore, a careful examination of posture should be a part of every medical examination, and the correction of postural faults, when found, should be insisted on.

2. Coöperation between the pediatrician and the orthopædist should be close in the care of these patients. In childhood, the correction of faulty posture is comparatively easy, and if these two work together, they should be able to prevent the bad effects which may follow its non-correction.

3. The child is but the forerunner of the adult. Its conformation forecasts what manner of man will result when maturity is attained, and hence, for the future welfare of the individual, posture in childhood becomes important.

—*F. G. Hodgson, Atlanta, Ga.*

INTERMITTENT HYDRARTHROSIS. Walter L. Bierring. *Jour. A. M. A.*, Sept. 3, 1921, p. 785.

A case is reported in detail, a man of thirty-six years who was observed over a period of five years. The swelling of the knee would begin, reach its height on the third day, and return to normal on the sixth day, then after an interval of exactly 12 days, the exact same cycle would be repeated. Later the other knee became involved with a cycle of five days and free interval of eleven days. The hydrarthrosis occurred with "clock-like regularity."

An historical summary, pathogenesis, and theories as to the nature of the process are given. References to 76 similar cases reported in the literature are given. No autopsies have been reported. The disease often continues without interruption for a long period of years. There is a distinct tendency to remissions or prolongation of the interval between attacks, and the ultimate result is favorable. No form of treatment seemed to have any decided curative effect.—*F. G. Hodgson, Atlanta, Ga.*

THE ILIOSACRAL JOINT. H. R. Allen. *Jour. A. M. A.*, Sept. 10, 1921, p. 854.

Both comparative and human anatomy of the pelvic girdle are discussed: also the action of the sacroiliac and pubic joints. Author suggests that the entire pelvis be taken in making roentgenograms, to show the relation of the pubic bones to the sacroiliacs. A better suggestion would have been stereoradiograms taken with a Potter-Bucky diaphragm. He suggests, in regard to treatment, grasping the crest of the ilium, or the pubes, or the ischial tuberosity on each side of the body for manipulation in the reduction of fractures or dislocation. Also through the rectum a firm grasp can be taken on the lower end of the sacrum.—*F. G. Hodgson, Atlanta, Ga.*

SCOLIOSIS ISCHIADICA ALTERNANS. A. Blencke. *Archiv. Orthop. und Unfall-Chir.*, Vol. xviii, 1-2, September, 1920.

The author quotes twelve cases in the literature showing alternating tilting of the body in sciatica. It is impossible to unite all symptoms into a common syndrome. In the cases in which the alternations of posture are involuntary, the clinical pictures have this in common: that the disease of the nerves was regularly extended to the lumbar region. Voluntary alternation could not be obtained in any of these cases. On the other hand, the cases in which there is voluntary change from contralateral scoliosis into homolateral scoliosis and *vice versa* have this in common, that the change of the lateral deviation is usually observed only after the acute symptoms of sciatica have disappeared and the trouble has persisted for some time.

To all cases is common, the presence of a sciatica, and in the course of the latter the lateral and often also the antero-posterior curves develop. Considering the complexity of the sacrolumbar plexus, the author points out that the neuralgias of the different sensory tracts of the lumbar and sacrolumbar plexus, also have different syndromes, which, however, cannot yet be sharply defined from each other and which often melt into each other, probably because of the intimate relations of their respective cortical and sub-cortical centers. In the opinion of Hoffa, the deviation of the spine is due to a reflex contracture. He himself suffered from severe sciatica and stated in his own case that the scoliosis occurred suddenly and was accompanied by subsidence of pain.

Lorenz concludes that the lumbar spine is bent reflexly by muscle spasm, with the convexity pointing to the affected side, in order to save the afflicted lumbar and sacrolumbar nerves from painful tension. The whole external picture of the trouble is built upon the lumbar curve as the basis. Lorenz then proved mathematically that in lumbar scoliosis with convexity to the diseased side, a minimum of tension of the lumbo sacral nerves occurs if the trunk is tilted contralaterally. On the other hand, if the lumbar curve points with its convexity to the sound side, a relaxation of the nerve plexus can only occur if the trunk is tilted to the affected side. Thale comes to the following conclusions based upon the anatomy of the plexus: A homolateral scoliosis occurs when the three sacral roots are involved and when in relaxing the latter the pelvis is dropped on the affected side; an alternating scoliosis occurs when all roots are involved and now the ones and now the others are being relaxed. The scoliosis is missing when the fifth lumbar nerve is involved.

A valuable contribution to the doctrine of sciatic scoliosis is given by the studies of Ehret of a group of cases with alternating scoliosis. The pain in the lumbar plexus automatically leads to homolateral and the pain in the sacral plexus to contralateral scoliosis. Ehret considers as an initial stage the still rarer cases of voluntary change of positon. All other changes which the different cases go through in recumbent position, in suspension, in forward bending of the body, can be explained easily by the fact that the relaxing agents of one type disappear and are immediately substituted by others. The many possibilities of relaxing the diseased nerve also explain the variety of the single individual histories. The greater possibility given by nature to shorten the nerve, the more variegated and different are the cases from each other.—*A Steindler, Iowa City, Iowa.*